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Society
FOR THE
Promotion of Engineering Education

PROCEEDINGS
OF THE
TWENTY-SEVENTH ANNUAL MEETING
HELD AT
JOHNS HOPKINS UNIVERSITY
BALTIMORE, MD.
JUNE 25-28, 1919

VOLUME XXVII

PUBLICATION COMMITTEE
JOHN F. HAYFORD · M. S. KETCHUM F L. BISHOP

F. L. BISHOP, EDITOR

PITTSBURGH, PA.
OFFICE OF THE SECRETARY
1919

PRESS OF
THE NEW ERA PRINTING COMPANY
LANCASTER, PA.

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OF THE

Society for the Promotion of Engineering Education

1918-1919

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G. R. Chatburn, Lincoln, Nebr.
Milo S. Ketchum, Boulder, Colo.

COMMITTEES OF THE SOCIETY.

A large part of the work of the Society is conducted by committees under the direction of a Committee on Committees and their work for the year 1919–20 are:

1. **Executive Committee:** Arthur M. Greene, Jr., W. O. Wiley and F. L. Bishop.

2. **Publication Committee:** Arthur M. Greene, Jr., W. O. Wiley and F. L. Bishop.

3. **Program Committee:** Arthur M. Greene, Jr., A. A. Potter, F. P. McKibben, W. O. Wiley and F. L. Bishop.

Committees Nos. 1, 2 and 3 have their work defined by the By-Laws of the Society.

4. **Committee on Committees:** Arthur M. Greene, Jr., W. O. Wiley, A. A. Potter, F. P. McKibben, Henry S. Jacoby, C. R. Mann and F. L. Bishop.

7. **Institutional Committee:** A. A. Potter, *Chairman,* A. F. Barnes, F. L. Bishop, H. S. Boardman, F. C. Bolton, G. M. Butler, G. A. Covell, F. T. Dargan, H. L. Dodge, H. S. Drinker, S. B. Earle, John T. Faig, J. H. Felgar, A. H. Fuller, L. A. Hazeltine, A. Lewis Jenkins, W. H. Kavanaugh, R. S. King, A. S. Langsdorf, A. O. Leuschner, E. J. McCaustland, F. W. McNair, Anson Marston, Chas. C. More, J. R. Nelson, H. N. Ogden, N. C. Riggs, Max B. Robinson, E. H. Rockwell, W. S. Rodman, H. B. Shaw, C. H. Snow, W. E. Stone, O. V. P. Stout, T. U. Taylor, R. G. Thomas, A. A. Titsworth, John C. Tracy, J. W. Votey, P. F. Walker.

To bring the policies of the Society to the attention of the executives and other teachers in their institutions and to represent the Society at the institutions.

8. **Committee on Admission:** O. V. P. Stout, *Chairman,* J. W. Hallock, C. E. Magnusson and C. M. Wirick.

Study of the methods of admission to engineering schools including European schools.

9. **Committee on Administration:** F. P. McKibben, *Chairman,* W. G. Raymond, John T. Faig.

10. **Committee on Mathematics:** L. C. Plant, *Chairman,* E. R. Hedrick and C. E. Comstock.

Coöperate with the American Mathematical Society.

11. **Committee on Physics:** G. W. Stewart, *Chairman,* F. K. Richtmyer, Barry MacNutt and H. H. Higbie.

Study of the first course in Physics.

11-B. **Joint Committee on Chemistry:** R. M. BIRD, *Chairman*. American Chemical Society: H. P. TALBOT, S. W. PARR and R. H. MCKEE.

Society for the Promotion of Engineering Education: R. M. BIRD, J. H. JAMES and J. R. WITHROW.

12. **Committee on English:** C. W. PARK, *Chairman*, J. R. NELSON, SADA HARBARGER and FRANK AYDELOTTE.

Continue the study of the present status of the teaching of English to engineers.

13. **Committee on Mechanics and Hydraulics:** O. H. BASQUIN, *Chairman*, J. E. BOYD, C. H. BURNSIDE, H. F. MOORE and C. I. CORP.

The main objectives in teaching these subjects.

14. **Committee on Economics:** C. C. WILLIAMS, *Chairman*, A. B. McDANIEL, P. F. WALKER, J. W. DIETZ and E. B. PAINE.

Work defined by Committee.

15. **Committee on Civil Engineering:** A. H. FULLER, *Chairman*, W. C. HUNTINGTON, H. J. BURT, C. T. MORRIS and J. HAMMOND SMITH.

Methods and details of teaching structural design.

16. **Committee on Mechanical Engineering:** W. W. BIRD, *Chairman*, B. W. BENEDICT, W. W. CARLSON, H. WADE HIBBARD, A. LEWIS JENKINS and A. L. WILLISTON.

Methods of teaching shop work.

17. **Committee on Electrical Engineering:** C. F. HARDING, *Chairman*, O. J. FERGUSON, ALEXANDER GRAY, H. E. DYCHE, F. T. DARGAN, E. J. BERG and H. B. SHAW.

A study of the present practice in regard to the teaching of direct currents and alternating currents versus the teaching of the electrical currents.

18. **Committee on Mining Engineering:** F. W. SPERR, *Chairman*, E. A. HOLBROOK, J. B. PORTER, H. H. STOEK and H. E. T. HAULTAIN.

Continue present investigations.

20. **Committee on the Standardization of Technical Nomenclature:** JOHN T. FAIG, *Chairman*, W. D. ENNIS, F. N. RAYMOND, CHAS. WARREN HUNT and S. E. MOSS.

21. **Committee on R. O. T. C.:** CHARLES S. HOWE, *Chairman*, C. RUSS RICHARDS, F. P. McKIBBEN, A. E. BURTON, W. M. THORNTON, A. L. WILLISTON, F. L. BISHOP.

To coöperate with the War Department.

22. **Committee on Intelligence Tests:** L. L. THURSTON, *Chairman*, WM. T. MAGRUDER, ANSON MARSTON, DUGALD C. JACKSON and C. R. DOOLEY.

23. **Committee to Coöperate with the American Society of Mechanical Engineers:** C. L. MEES, *Chairman*, A. B. McDANIEL, W. S. RODMAN, E. S. FESSENDEN and L. M. DEFOE.

24. **Committee on Degrees:** A. E. KENNELLY, *Chairman*, F. L. PRYOR, C. F. SCOTT, HAROLD PENDER, F. W. SPERR, C. T. MORRIS, F. P. SPALDING, P. F. WALKER, C. L. CORY.

FINAL PROGRAM OF THE 27th ANNUAL MEETING, THE JOHNS HOPKINS UNIVERSITY, HOMEWOOD, BALTIMORE, MD., JUNE 25–28, 1919.

Wednesday, June 25.

11:30 A. M.—Meeting of the Council at Johns Hopkins Club.

2:00 P. M.—Opening Session.

President Hayford presiding.

Address of Welcome. Frank J. Goodnow, President, The Johns Hopkins University.

Response. John F. Hayford, President of the Society.

Report of Special Committee on the report of the Joint Committee on Engineering Education, W. E. Mott, *Chairman.*

Paper—The Case System for the Study of Law; What it is, and its Bearing on Engineering Education, by C. F. Allen, West Roxbury, Mass.

Paper—Mental Tests for Engineering Students, by Walter V. Bingham, Carnegie Institute of Technology, Pittsburgh, Pa.

Paper—Vocational Intelligence Examination to IV Year M. E. Students, by Wm. T. Magruder, The Ohio State University.

Report of Committee No. 15, Civil Engineering, A. H. Fuller, *Chairman.*

Paper—Highway Transport Engineering, by A. H. Blanchard, President, National Highway Traffic Association, New York City.

Appointment of Committees on Resolutions and Nominations.

8:00 P. M.—Annual mixer meeting at Baltimore Country Club.

Thursday, June 26.

9:00 A. M.—Meeting of the Council.
9:30 A. M.—Second Session.

Paper—Effect of the War on Engineering Education.

Discussion: Anson Marston, K. G. Matheson, Carl C. Thomas. A. G. Christie.

Report of Committee No. 8, Admission, E. F. Coddington, *Chairman.*

Report of Committee No. 10, Mathematics, L. C. Plant, *Chairman.*

Report of Committee No. 11-A, Physics, G. W. Stewart, *Chairman.*

Report of Committee No. 12, English, C. W. Park, *Chairman.*

Paper—The Unconscious Plagiarist, by G. I. Mitchell, University of Pittsburgh.

12:00 M.—Informal luncheon for convention in Machinery Hall.

2:00 P. M.—Third Session.

Paper—Military Training in Engineering Schools, by Col. F. J. Morrow, Chairman, Committee on Education and Special Training of the War Department.

Discussion: Charles S. Howe, Capt. George R. Guild.

Paper—The Coast Artillery and the Reserve Officers' Training Corps, by Major Harrison Tilghman, Fort Monroe.

Report of Committee No. 16, Mechanical Engineering. O. A. Leutwiler, *Chairman.*

Paper—Teaching Safety in Engineering Schools, by George W. Case, University of Pittsburgh.

Report of Committee No. 17, Electrical Engineering, C. Francis Harding, *Chairman.*

Report of Committee No. 18, Mining Engineering, F. W. Sperr, *Chairman.*

Report of Committee No. 20, Standardization of Technical Nomenclature, John T. Faig, *Chairman.*

7:30 P. M.—Annual dinner at Baltimore Country Club.

Presidential Address: "Reflections of an S. P. E. E. President." President John F. Hayford.

FRIDAY, JUNE 27.

9:00 A M.—Meeting of the Institutional Delegates.

9:30 A. M.—Fourth Session.

Paper—The Society for the Promotion of Engineering Education. A Survey of its Past and a Reconnaissance of its Future. George R. Chatburn, Past President, C. J. Tilden, The Johns Hopkins University.

Degrees, by E. O. Leuschner, University of California.

Paper—The Vitalizing Principles in Education, by Edward J. Kunze, Cooper Union.

Paper—Vocational Correlation, by O. J. Ferguson, University of Nebraska.

Report of the Treasurer.

Report of the Secretary.

11:00 A. M.—Leave the Johns Hopkins University by street car, taking train at Camden Station at 12:00 M. for Annapolis.

1:15 P. M.—Luncheon at Carvel Hall. Inspection of the United States Naval Academy and the Engineering Experiment Station.

6:00 P. M.—Take train for Baltimore.

8:00 P. M.—Informal smoker. Round Table Discussion.

9:00 A. M.—Meeting of the Council.

9:30 A. M.—Fifth Session.

Report of Committee on Resolutions.

Report of Committee on Nominations.

Election of Officers.

Paper—Engineering Colleges and Their Administration, by Ira N. Hollis, Worcester Polytechnic Institute.

Symposium on Changes in Courses.

The New Course at Tufts College, by Gardner C. Anthony, Tufts College.

J. R. Benton, University of Florida.

F. H. Constant, Princeton University.

George B. Pegram, Columbia University.

J. C. Tracy, Yale University.

A. A. Potter, Kansas State Agricultural College.

F. C. Bolton, A. & M. College of Texas.

Dugald C. Jackson, Massachusetts Institute of Technology.

F. L. Bishop, University of Pittsburgh.

Report of Committee No. 11-B. Chemistry, R. M. Bird, *Chairman.*

Report of Committee No. 13, Mechanics and Hydraulics, O. H. Basquin, *Chairman.*

Report of Committee No. 14, Economics, C. C. Williams, *Chairman.*

Paper—Visual Industrial Course, by Collins P. Bliss, New York University.

12:30 P. M.—Adjournment.

MEETING PLACE.

Mechanical and Electrical Engineering Building, The Johns Hopkins University, Homewood, Baltimore, Md.

REGISTRATION AND INFORMATION.

The place of registration and general information will be in one of the rooms of the Mechanical and Electrical Engineering Buildings.

RECREATION AND EXCURSIONS.

The Local Comittee has arranged a luncheon for the first meeting of the Council at the Johns Hopkins Club at 12:30 P. M., Wednesday, June 25. The annual mixer meeting will be held at the Baltimore Country Club, Wednesday evening at 8:00 P. M., and the annual dinner at the same place Thursday evening at 7:30 P. M. This dinner will be $3.00 per plate. Friday afternoon has been set aside for a trip to the U. S. Naval Academy and the Engineering Experiment Station. Street cars will leave the University at 11:00 A. M. in order to make connections at Camden Station with the train leaving there at 12 M. Luncheon will be served at Carvel Hall, Annapolis, at 1:15 at 75c per person. There will be an informal smoker on Friday evening at 8:00 P. M., the location to be announced at the meeting.

Headquarters will be established at The Rennert. The rates are single rooms without bath, $1.50 to $2.50; with bath, $2.50 to $5.00, single; second person in room $1.50 additional.

Other hotels and rates are:

Southern Hotel—$3 and $4 per day, single; $5 $6 and $7 per day, double. Every room has bath.

Belvedere Hotel—$3 and $4 per day, single; $5 $6 and $7 per day, double.

The Emerson—Rooms without bath, $3.50 and $4; with bath, $4 and $4.50. Room with bath, two persons, $7 and $7.50 per day.

LOCAL COMMITTEES.

John B. Whitehead, *Chairman.*

Committee on Rooms and Meals.—A. G. Christie, *Chairman,* J. H. Bringhurst, J. C. Smallwood, M. W. Pullen.

Committee on Relations with Non-Members and Entertainment of Visiting Ladies.—C. J. Tilden, *Chairman,* J. H. Gregory, J. E. Greiner.

Committee on Arrangements in Mechanical and Electrical Engineering Building.—J. B. Whitehead, *Chairman,* A. G. Christie, W. B. Konwenhoven, J. C. Smallwood, M. W. Pullen.

Committee on Excursions and Entertainment.—C. J. Tilden, *Chairman,* L. A. Doggett, W. B. Konwenhoven, J. B. Scarborough, R. E. Root, C. A. Styer.

OFFICERS FOR THE 1919 MEETING.

JOHN F. HAYFORD, *President.*

Vice-Presidents.

JOHN T. FAIG, E. R. MAURER.

W. O. WILEY, *Treasurer.*
F. L. BISHOP, *Secretary.*

MEMBERS AND GUESTS REGISTERED AT MEETING.

Allen, C. F.,
Allen, Chester,
Anthony, G. C.,
Barnes, A. F.,
Beckstrand, E. H..
Benton, J. R.,
Berg, E. J.,
Bishop, F. L.,
Bishop, F. L., Jr.,
Bishop, F. L., Mrs.,
Blanchard, A. H.,
Bliss, Collins P.,
Boardman, H. S.,
Bolton, F. C.,
Bringhurst, J. H.,
Bringhurst, J. H., Mrs.,
Browne, Wm. Hand, Jr.,
Bozell, H. V.,
Boyer, F. Q.,
Berger, W. H.,
Burden, H. P.,
Butler, G. M.,
Case, G. W.,
Comstock, C. E.,
Chase, H. W.,
Chase, L. W.,
Chatburn, G. R.,
Covell, G. A.,
Christie, A. G.,
Cleghorn, M. P.,
Coddington, E. F.,
Constant, F. H.,
Conner, S. L.,
Crandell, J. S.,
Dabney, C. W.,
Davis, Geo. Jacob, Jr.,
Dodge, H. L.,
Daggett, P. H.,
Dargan, F. T.,
Dargan, F. T., Mrs.,
Dargan, Elizabeth, Miss,
Danforth, R. H.,
Dietz, J. W.,
Daugherty, R. L.,
Dearborn, R. H.,
Disque, R. C.,
Doggett, L. A.,
Dunham, J. H.,
Duffey, C. F.,
Duckering, W. E.,
Eldred, C. P.,
Earle, S. B.,
Evans, F. H.,
Ellis, C. A.,
Emory, F. L.,
Faig, J. T.,
Felgar, J. H.,
Fermier, E. J.,
Fuller, A. H.,
Fish, F. A.,
Flather, J. J.,
Gibson, A.,
Gregory, J. H.,
Greene, A. M., Jr.,
Gunner, J. E.,
Griswold, R. G.,
Hamilton, E. P.,
Hayden, Frank D.,
Hayford, John F.,
Hatt, W. H.,
Hazeltine, L. A.,
Hickerson, T. F.,
Harbarger, Sada A.,
Henderson, W. E.,
Hoffman, George A.,
Holbrook, E. A.,
Holden, C. A.,
Holden, C. A., Mrs.,
Huntington, E. V.,
Jabine, L.,
Jackson, D. C.,
Jenkins, A. L.,

Jones, B. O.,
Jones, C. R.,
Kavanaugh, W. H.,
Kunze, E. J.,
Kinsley, Carl,
King, R. S.,
Lanagan, W. H.,
Lear, J. E.,
Langsdorf, A. S.,
Leuschner, E. O.,
Lapham, John R.,
Leland, O. M.,
LePaige, C. B.,
LePaige, Lois, Miss,
Leutwiler, O. A.,
McCaustland, E. J.,
McDaniel, A. B.,
McKenry, Nell, Miss,
MacKavanaugh, Thos. J.,
McRae, A. L.,
McKibben, F. P.,
McNair, F. W.,
Macdonald, T. H.,
Magruder, W. T..
Marquis, F. W.,
Marston, Anson,
Mann, C. R.,
More, C. C.,
Morrow, F. J.,
Mott, W. E.,
Mustard, J. H.,
Nelson, J. R..
Newcomb, J. L.,
Park, C. W.,
Pegram, G. B.,
Potter, A. A.,
Pullen, M. W.,
Rice, L. H.,
Roberts, E. B.,
Reybold, E.,
Robinson, M. B.,
Robinson, M. B., Mrs.,
Rockwell, E. H.,
Rodman, W. S.,
Rohrer, A. L.,
Root, Ralph E.,
Read, T. T.,
Riggs, N. C.,
Russell, Walter B.,
Randolph, L. S.,
Rittenhouse, L. H.,
Stout, O. V. P.,
Smith, E. T.,
Sackett, R. L.,
Shaw, H. B.,
Snow, Chas. H.,
Snow, Louis F.,
Styer, C. A.,
Sypherd, W. O.,
Summers, R. H.,
Taylor, T. U.,
Thomas, R. G.,
Thomas, C. C.,
Thomas, C. C., Mrs.,
Thompson, J. S.,
Titsworth, A. A.,
Thornton, W. M.,
Thurstone, L. L.,
Tilden, C. J.,
Tilden, C. J., Mrs.,
Tilghman, Harrison,
Tracy, J. C.,
Turneaure, F. E.,
Votey, J. W.,
Walker, E. D.,
Walker, P. F.,
Watkins, L. H..
Wickenden, W. E.,
Williams, C. C.,
Williams, J. P. J.,
Wilson, A. M.,
Wilson, W. L.,
Williston, Arthur L.,
Wirick, C. M.,
Whitehead, J. B.,
Weschler, George A.,
Wiley, W. O.

MINUTES OF THE TWENTY-SEVENTH ANNUAL MEETING.

The Johns Hopkins University, Baltimore, Md.
June 25–28, 1919.

The twenty-seventh annual meeting of the Society for the Promotion of Engineering Education was held at The Johns Hopkins University, Baltimore, Md., June 25 to 28, 1919. The sessions were held in the Mechanical and Electrical Engineering Building.

MINUTES OF THE REGULAR SESSIONS.

Wednesday, June 25.

Opening Session.

The meeting was called to order at 2:00 P.M. by President John F. Hayford, Director of the College of Engineering, Northwestern University. President Frank J. Goodnow of The Johns Hopkins University welcomed the Society to the University and President Hayford responded for the Society.

The Special Committee appointed to make a study of the report of the Joint Committee on Engineering Education reported at this time followed by two papers dealing with this subject: "Mental Tests for Engineering Students," by L. L. Thurstone, and "Vocational Intelligence Examination to IV Year M. E. Students," by Wm. T. Magruder. A discussion followed.

The President announced the following as members of the Committee on Resolutions: O. M. Leland, *chairman*, R. S. King and W. H. Burger.

THURSDAY, JUNE 26.

Second Session.

The meeting was called to order at 9:30 with President Hayford in the chair. A list of seventeen individual and one institutional applicants, which had been approved by the Council, was favorably acted upon by the Society.

Professor C. F. Allen presented a paper on "The Case System for the Study of Law; What it is, and its Bearing on Engineering Education." Professor A. H. Fuller presented the report of Committee No. 15, Civil Engineering, followed by the paper on "Effect of the War on Engineering Education" by Dean Anson Marston.

The Committee appointed by the Council to consider the desirability of encouraging the formation of sections in the Society reported as follows:

1. That the Society authorize and encourage the formation of sections in cities, states or other geographic divisions.
2. The objects of these sections are to advance the ideals and standards of engineering education and to increase interest in the activities of the S. P. E. E.
3. Sections may be formed in any locality by temporary organizations which shall become duly authorized sections of the S. P. E. E. upon approval by the Council.
4. Sections shall not expend any of the Society's funds; they shall be self supporting.

(signed) J. T. FAIG,
W. E. MOTT,
A. A. POTTER, *Chairman.*

This report was favorably acted upon by the Society.

Third Session.

The meeting was called to order by President Hayford at 2:00 P.M. Col. F. J. Morrow read a paper on "Military Training in Engineering Schools." In the absence of President Charles S. Howe, Chairman of the Committee of this Society to coöperate with the Committee on Education and Special Training in this work, the Secretary read the report of this committee. It was regularly moved and carried that this Committee be enlarged by the addition of two more members and that they meet with the Committee on Education and Special Training in Washington, Monday, June 30, 1919.

Major Harrison Tilghman read a paper on "The Coast Artillery and the Reserve Officers Training Corps." The following resolution was unanimously adopted. A motion that this Society present to Colonal Morrow and to Major Tilghman and the other officers present a vote of thanks and high appreciation for the papers and the information that they had given, and that we express through them to the War Department the purpose of the engineering schools of this country to do all they can to back up the movement for insuring the preparedness of America in case of future difficulties.

Dean E. F. Coddington read the report of Committee No. 8, Admission; the Secretary read the report of Committee No. 11-A, Physics, in the absence of the chairman, Professor G. W. Stewart. Professor C. W. Park, Miss Sada A. Harbarger and Professor J. Raleigh Nelson presented the report of Committee No. 12, English. The paper, "The Unconscious Plagiarist," by G. I. Mitchell, was read by title. Professor O. A. Leutwiler presented the report of Committee No. 16, Mechanical Engineering. Professor George W. Case presented an illustrated paper on "Teaching Safety in Engineering Schools."

The report of Committee No. 17, Electrical Engineering, was read by title. Professor F. W. Sperr presented the report of Committee No. 18, Mining Engineering, and President John

T. Faig presented the report of Committee No. 20, Standardization of Technical Nomenclature.

FRIDAY, JUNE 27.

Fourth Session.

The meeting was called to order at 9:30 with President Hayford in the chair. Past-President George R. Chatburn presented a paper, " The Society for the Promotion of Engineering Education. A Survey of its Past and a Reconnaissance of its Future." Dean E. O. Leuschner read his paper on " Degrees," which lead to the motion that a committee of five be appointed to make a study of degrees.

Excursions.

SATURDAY, JUNE 28.

Fifth Session.

The meeting was called to order by President Hayford at 9:00 A.M. Professor Edward J. Kunze presented a paper, "The Vitalizing Principles in Education." In the absence of Professor O. J. Ferguson, his paper, " Vocational Correlation," was read by title. The treasurer, Mr. W. O. Wiley, presented his report which upon motion was accepted. The secretary presented his report and upon motion it was accepted and to be printed in the PROCEEDINGS as read.

The Committee on Resolutions reported as follows:

WHEREAS, the investigations resulting in the report by Dr. C. R. Mann, entitled " A Study of Engineering Education," constitute a most valuable contribution to the work which it is the object of this Society to promote, therefore, be it

Resolved, that the thanks of this Society are due the Carnegie Foundation for the Advancement of Teaching for its generosity in providing the means of carrying on the investigations and publishing the report; to the president and directors of the Foundation for their personal interest and coöperation; and to Dr. Mann for his masterly and comprehensive treatment of the subjects considered; and further be it

Resolved, that this Society expresses its appreciation of the assistance of the other national societies represented on the Joint Committee for the prosecution of this work, namely, the American Society of Civil Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, the American Chemical Society, the American Institute of Chemical Engineers, and the American Institute of Mining Engineers, and further be it

Resolved, that the Secretary of this Society transmit to the above organizations and to Mr. Andrew Carnegie copies of these resolutions.

Resolved, that the cordial thanks of the Society be extended to the President, the members of the several local committees, and the ladies of The Johns Hopkins University for the hearty welcome and courteous and kindly treatment which have been accorded the members of the Society; and for the use of the buildings and accommodations which have been such a factor in making this meeting so pleasant and profitable; further be it

Resolved, that the Secretary be instructed to convey to the officers of the Baltimore Country Club the appreciation of the Society for their hospitality in extending the courtesies of the Club; further be it

Resolved, that the thanks of the Society be transmitted to the Superintendent of the United States Naval Academy for the entertainment of the Society at Annapolis, and further be it

Resolved, that the Society thanks those officers of the United States Army who, in the pressure of official duties, took the time to be present at this meeting, in order to furnish information concerning subjects which are of such great moment to the work of the engineering colleges at the present time.

The Nominating Committee reported as follows:

For officers to serve one year:

For President: Arthur M. Greene, Jr., Rensselaer Polytechnic Institute.

For Vice-Presidents: A. A. Potter, Kansas State Agricultural College. F. P. McKibben, Union College.

For Secretary: F. L. Bishop, University of Pittsburgh.

For Treasurer: W. O. Wiley, New York City.

For members of the Council to serve for three years: H. S. Boardman, University of Maine; F. C. Bolton, Agricultural and Mechanical College of Texas; E. F. Coddington, The Ohio State University; W. H. Kavanaugh, University of Pennsylvania; C. C. More, University of Washington; E. H. Rockwell, Tufts College; W. S. Rodman, University of Virginia.

On motion, the Secretary was instructed to cast a unanimous ballot in favor of all the above candidates.

President Ira N. Hollis read his paper, "Engineering Colleges and their Administration." The resolution proposed in the report of the secretary that "a standing joint committee should be provided to coördinate the educational activities of the engineering societies with this Society, thus preventing useless duplication and at the same time bringing this Society in contact in the best possible manner with technical societies" was adopted. Dean Gardner C. Anthony read his paper, "The New Course at Tufts College," followed by Dean J. R. Benton, Dean A. A. Potter, Professor J. C. Tracy, Professor F. C. Bolton, Major C. C. More. In the absence of Professor R. M. Bird, the Secretary read the report of Committee No. 11-B, Chemistry. Professor O. H. Basquin presented the report of Committee No. 13, Mechanics and Hydraulics, and Professor C. C. Williams the report of Committee No. 14, Economics. Professor Collins P. Bliss presented his paper, "Visual Industrial Course." President Hayford introduced the new president, Arthur M. Greene, Jr., who graciously accepted the office. The convention then adjourned *sine die*.

MINUTES OF COUNCIL MEETINGS HELD JUNE 25, 26 AND 28, 1919.

Meetings of the Council were held on June 25, 26 and 28. Members who attended one or more meetings were: C. F. Allen, Gardner C. Anthony, F. L. Bishop, A. H. Blanchard, Wm. Hand Browne, George R. Chatburn, John T. Faig, John F. Hayford, Dugald C. Jackson, O. A. Leutwiler, Wm. T. Magruder, W. E. Mott, E. J. McCaustland, F. W. McNair, J. Raleigh Nelson, A. A. Potter, T. U. Taylor, C. J. Tilden and W. O. Wiley.

The motions passed were as follows:

1. That the invitation of the St. Louis Chamber of Commerce to hold the next meeting of the Society in St. Louis on May 24 to 27, 1920, not be accepted due to the fact that the time set is impracticable for the majority of institutions.

2. That the Secretary investigate the subject of associate editors in connection with the BULLETIN of the Society, and report at the next meeting.

3. That it is the policy of the Society that only members of the Society be appointed to serve on committees.

4. That a committee of Council be appointed to take up the subjects of sections in the Society and report. This committee reported as follows:

The Committee appointed by the Council to consider the desirability of encouraging the formation of sections, begs to report as follows:

1. That the Society authorize and encourage the formation of sections in cities, states or other geographic divisions.

2. The objects of these sections are to advance the ideals and standards of engineering education and to increase interest in the activities of the Society for the Promotion of Engineering Education.

3. Sections may be formed in any locality by temporary organizations which shall become duly authorized sections of the Society for the Promotion of Engineering Education upon approval by the Council.

4. Sections shall not expend any of the Society's funds; they shall be self-supporting.

Respectfully submitted.

J. T. Faig,
W. E. Mott,
A. A. Potter

This report was presented to the members at the meeting Thursday and adopted.

5. That the institutional delegate from each institution be appointed by the Council as a special delegate from his institution to see to the increase of membership during the coming year.

6. That the Council appoint and request a member from each institution having members in the Society, to see to the increase of membership during the coming year.

7. That the next meeting of the Society be held in an institution in the Middle West in June, the place to be decided by the Council.

8. That three members of the Society be elected to represent the Society on the American Council on Education. The following were elected:

C. R. Mann, to serve for one year;
F. W. McNair, to serve for two years;
F. L. Bishop, to serve for three years.

9. That a committee be appointed to study the bill relating to the loaning of equipment owned by the War Department to educational institutions and report to the Council. The following resolution was presented and upon motion adopted and the Secretary instructed to send a copy to the author, Mr. Caldwell, who introduced H. R. 3142 into the 66th Congress, May 26, 1919:

The Council of the Society for the Promotion of Engineering Education believes it desirable that machine tools and scientific equipment owned by the War Department, not in use for Government purposes, be used for increasing the educational facilities of trade and technical schools, colleges and universities. It believes also that such tools and equipment can be made most useful by outright sale to the institutions at nominal prices, instead of by loans, for the reason that loans will introduce administrative difficulties on the part of the Government and institutions, which will place an unnecessary financial burden on both. Institutions obtaining machine tools and scientific equipment from the Government at nominal prices should obligate themselves not to sell these for a period of at least seven years from date of sale.

(signed) Dugald C. Jackson,
A. A. Potter,
E. J. McCausland,
J. T. Faig.

10. That the report of the treasurer be accepted and recommended to the meeting for adoption.

11. Following the recommendation of the Treasurer, Mr. Wiley, the following action was taken:

That the Secretary's office take over the collection of dues this year, and the other recommendations from Mr. Wiley be carried out as soon as possible.

12. The following applicants were recommended to the Society for election:

Abbott, Robinson; Baker, Ray Palmer; Burbank, Colby Lewis; Frey, George John; Gregg, John M.; Hill, A. S.; Jenkins, A. L.; June, Henry Norton; Mann, Horace Tharp; Reybold, Eugene; Roberts, Emerson; Seavey, Frank Elias; Shank, Jacob Ralph; Sheehan, Thomas W.; Thurston, L. L.; Tilghman, Harrison; Watt, Homer A.; Weaver, Rudolph; Williams, J. P. J.; The Harvard Engineering School, Harvard University, Cambridge, Mass.; The University of Texas, Austin, Tex.

13. The following budget of income and expense for the coming year was reported by the Executive Committee and adopted by the Council:

Estimated Receipts.

From current dues, individual	$5,252.00
From current dues, institutional	700.00

From back dues	700.00
From advertising	1,000.00
From sale of publications	250.00
Estimated receipts	$7,902.00

Estimated Expense.

A.	Baltimore meeting (1919)	$300.00	
B.	Proceedings, Vol. 27	1,200.00	
C.	Engineering Education, Vol. X	1,600.00	
D.	Committee Expenses	150.00	
E.	Treasurer's honorarium	300.00	
F.	Secretary's honorarium	1,000.00	
H.	Clerical assistant	1,200.00	
I.	Sundry printing	250.00	
J.	Postage and expressage	275.00	
K.	Telephone and telegraph	50.00	
F.	Office supplies	125.00	$6,450.00
	Estimated surplus		$1,452.00

The Officers elected for 1919–20 are:

President: Arthur M. Greene, Jr., Rensselaer Polytechnic Institute, Troy, N. Y.

Vice-Presidents: A. A. Potter, Kansas State Agricultural College, Manhattan, Kans.; F. P. McKibben, Union College, Schenectady, N. Y.

Treasurer: W. O. Wiley, 432 Fourth Avenue, New York, N. Y.

Secretary: F. L. Bishop, University of Pittsburgh, Pittsburgh, Pa.

Members of the Council to serve for three years (1919–1922): H. S. Boardman, University of Maine, Orono, Me.; F. C. Bolton, A. & M. College of Texas, College Station, Tex.; E. F. Coddington, The Ohio State University, Columbus, O.; W. H. Kavanaugh, University of Pennsylvania, Philadelphia, Pa.; C. C. More, University of Washington, Seattle, Wash.; E. H. Rockwell, Tufts College, Tufts College, Mass.; W. S. Rodman, University of Virginia, University, Va.

TREASURER'S REPORT.

June, 1919.

Receipts:		
Cash on hand, June, 1918		$1,536.92
Received from back dues	$878.64	
Received from current dues	4,515.42	
Received from other sources	1,091.12	$6,485.18
Total Receipts		$8,022.10
Disbursements:		
Annual Meeting, 1918	$426.89	
Bulletin	15.00	
Committee expenses	114.60	
Treasurer's office	330.66	
Secretary's honorarium	626.95	
Secretary's clerical assistance	1,190.00	
Sundry printing	146.86	
Postage and expressage	296.90	
Telephones and telegrams	29.79	
Office sundries	61.02	
University of Pittsburgh (voucher not returned)	34.87	
Accounts payable, June, 1918	3,671.55	
A. S. M. E. (Elmer Bark)	15.00	$6,960.09
Balance on hand		$1,062.01
Assets:		
Accounts Receivable:		
Current dues	$1,581.50	
Back dues	2,746.72	
Institutional—		
Current dues	110.00	
Back dues	92.50	
Members and non-members	548.37	
At Dr. Bishop's office	38.94	
Total accounts receivable	$5,118.03	
Inventory	$2,546.00	
Cash—Lincoln Trust Co.	614.75	
Cash—Life Membership Fund	447.26	
Cash—Dr. Bishop's office	150.00	
Total assets		$8,876.04
Liabilities:		
Members paid in advance	$349.85	
Due Dr. Bishop (honorarium)	373.05	
New Era Printing Co.	3,393.01	
Albert E. P. Kerr Co.	293.50	
Total liabilities		$4,409.41

REPORT OF SECRETARY.

The Society for the Promotion of Engineering Education has with other organizations had its trials and tribulations during the period of the war. The Society rendered distinct service in various ways which the Secretary will not dwell upon in this report. However, one of the features should be mentioned and that is the special meeting held at Boston, December 6 and 7, 1918. When the British Educational Mission was invited to this country by the Council of National Defense, its entertainment was turned over to the American Council on Education by the State Department and the Council of National Defense.

In connection with its entertainment, the Society was asked to hold a meeting in some suitable place preferably Boston, in connection with their meeting. The time and place of the meeting and the general topics of the program were selected by the Committee of the American Council on Education which had charge of the entertainment of the British delegation. The Program Committee of the Society arranged the program along these lines and conducted the meeting. This meeting was well attended. The papers and discussions were published in the *Bulletin* of the Society. These papers have brought fourth many words of commendation from educators and others.

There are 1,444 individual and 69 institutional members of the Society. During the past year 90 members were added, 4 institutional, and 91 members resigned or were dropped for non-payment of dues. This cleans up the membership list in a very satisfactory way. It will not be necessary to drop hardly any for the non-payment of dues this next year. About 75 members who were in the service took advantage of the regulation of the Society which permitted the suspension of their dues during the period of active service.

The Secretary's office conducted a campaign for new members starting in the fall of 1918 when letters were sent to members asking the names of individuals who might be interested in joining the Society. About 1,500 names were received in this manner. Letters and circulars were sent to the members of the Council asking each one to secure at least one new member. By this process, 26 members have been added to the Society. The Secretary believes that during the coming year the membership should be increased by 125 to 150.

Due to the increased cost of paper and labor Engineering Education, the *Bulletin* of the Society, has cost about $600 more during the present year than was estimated. Part of this, of course, will be credited to next year's volume of PROCEEDINGS. It was found impossible to issue either the *Bulletin* of the PROCEEDINGS on time up to the very last numbers, because of the New Era Printing Company being closed on account of influenza.

The Secretary's office has received numerous requests during the past year to suggest names of men for different teaching positions. A considerable list of names available is always on hand.

The coöperation between the Treasurer's and Secretary's offices has been developed and the Secretary sent out letters to delinquents with fairly satisfactory results. This work can be pushed during the coming year. It is believed that a larger per cent. of current dues has been collected this year than any previous year.

The Society has been represented on the American Council on Education by President F W. McNair, Dr. C. R. Mann and the Secretary. A Committee consisting of Presidents C. S. Howe, Dean C. Russ Richards, Professor F. P. McKibben, Dean A. E. Burton, and Dean F. L. Bishop was appointed to coöperate with the Committee on Education and Special Training of the War Department in connection with the establishment of the R. O. T. C. in engineering schools.

Dean W. E. Mott, of the Carnegie Institute of Technology, represented the Society at the conference called by the Bureau of Education on commercial education.

The committee work of the Society was taken up with renewed interest by all committees in January and almost without exception the committees have been doing excellent work. The Secretary believes that this is an important work of the Society since it provides continuous effort of the Society along various definite lines. Results in education can be obtained only by continuous efforts in systematic way and these standing committees of the Society provided that for various phases of engineering education.

The report of the Joint Committee on Engineering Education was during the past year, placed in the hands of all members of the Society and has been the subject of discussion at this meeting. This illustrates one phase of work in the matter of coöperation with other engineering societies. The Secretary believes that a standing joint committee should be provided to coördinate the educational activities of the engineering societies with this Society thus preventing useless duplication and at the same time bringing this Society in contact in the best possible manner with technical societies. Those of us who have been members of educational committees of technical engineering societies know how hard it is to secure results that are at all satisfactory.

The Secretary's office has received during the past year a considerable number of inquiries from foreign countries relative to engineering education and the work of this Society. These are in addition to the very large number of inquiries received from individual and educational institutions in this country. It might be interesting to note that the Secretary's office during the past year has placed something over 8,500 pieces of first- and second-class matter in the mail.

ADDRESS OF WELCOME.

BY FRANK J. GOODNOW,

The Johns Hopkins University.

It gives me great pleasure to avail myself of the privilege which is mine as representing the Johns Hopkins University to welcome the members of the Society for the Promotion of Engineering Education at their meeting on this occasion. The university esteems it an honor that you have accepted our invitation to carry on your deliberations within our halls. Our feeling of gratification is due to two considerations. In the first place we feel pleased that you are here. In the second place we congratulate ourselves that, although we have perhaps the youngest engineering school in the country, you have been willing to welcome this infant, so to speak, among the ranks of mature men. We feel sure that we shall profit greatly as we listen to the words which you will utter, based as they will be, on your long experience in the field which we all are cultivating.

I feel, however, that my words of welcome should be accompanied by an apology, perhaps, I should say apologies. For as I see it two apologies are due. One, an institutional apology. The other, a personal apology.

I have referred to the youth of our engineering school. Now youth, whatever may be the advantages, which are its incident, is subject to certain disadvantages. Our institutional youthfulness consists not merely in the recent establishment of our school but as well in the fact that the university, of which the school is a part, has been located at its present site for only a very short time. We have had neither the time nor unfortunately the money necessary to put our physical environment into a condition which permits us to offer to you the kind of hospitality which you deserve. We have no dormitories in which we can give you accommodation nor a commons in which the material wants of the inner man can be satisfied. We must perforce ask you to make a somewhat long journey from your hotels to Homewood, and to pick up a hasty lunch in the midst of the machinery with which your work days are perhaps too familiar.

When I think of what we can offer you I am somewhat amazed at our audacity in inviting you to hold your meeting here. I fear indeed that had you known our conditions you would have hesitated somewhat before consenting to come.

But we are glad to have you with us and I hope that your meeting will be successful, profitable, and interesting.

I have said I owed you a personal as well as an institutional apology. That apology is due for what I am going to say apart from these few words of welcome. It has been my fate to be president of an institution which pays comparatively little attention to those branches of study with which my past work has made me familiar. A lawyer I have been for the past five years, connected with an institution which has no law school. With little, if any knowledge, of science or the mechanical arts I have been obliged to concern myself with questions to whose solution I have been able to contribute but little. You can well imagine that during the past five years I have had to submit myself to a process of education.

So when it becomes my privilege to address the Society for the Promotion of Engineering Education, and when I realize that I am venturing to say something on the subject which specially concerns that society I am reminded of a story I heard the other day of a university president who had been long in the harness and who knew pretty well what was to be expected at such functions as university presidential inaugurations. He was in a train en route for one of these ceremonies when a friend saw him and asked him where he was going. His reply was "Oh, I am going to hear some first thoughts on education." When I recall that story I am conscious of the fact that I am taking perhaps an unjustifiable advantage of you in asking you to listen to some first thoughts on engineering education.

My only excuse for making this demand of you is that largely because of our recent experiences educational waters generally are stirring and I feel sure that the waters of engineering education are no exception to the rule.

Some of the first thoughts on this subject which have come to me, really a layman, are in the nature of queries rather than conclusions.

The most important as it seems to me is the query:

What is the purpose of an engineering school? Perhaps the query should not be framed this way. For it may well be that there is no such thing or should be no such thing as a typical engineering school. Perhaps there are and should be different types of these schools. If this is the case, then I suppose the query should be, what is the purpose of the particular school with which we happen to be connected? This query it seems to me we must answer before we can reach any really valuable conclusions as to the character of the engineering education which we should endeavor to provide.

As I have come to see it, engineering schools in general or any particular school may have one of three purposes. Perhaps, while any particular school may emphasize one of these purposes it may have the other purposes as well in mind.

Now these purposes as they outline themselves to one who comes without any experience and with very little knowledge to consider these problems are: (1) General education with emphasis laid on scientific subjects; (2) professional training; and (3) engineering research.

Some schools which I imagine may be classed as engineering schools started as scientific schools, *i.e.,* schools in which it was sought to give a general education through the study of subjects scientific rather than literary in character. Many schools which when organized were schools for the cultivation of mechanic arts have become schools devoted to general education with emphasis laid on the sciences and giving little if any attention to classical studies. There is further, little doubt that many of the graduates of engineering schools do not as a matter of fact make engineering in any of its branches their profession, while it is also true, I believe, that some eminent engineers never had an academic engineering training but went from a so-called literary college into the practical work of the engineering profession.

Now, if the purpose of engineering education, or perhaps I should say if the purpose of an engineering school is to give its students a general education which will be of benefit to them in other than the clearly professional ranks of life the problems which present themselves are very similar to those presented in the ordinary college. They are not exclusively intellectual but are as well moral problems. What must be sought is in some way to foster the building up of character, the cultivation of industry, particularly intellectual honesty, the capacity to evaluate correctly the things which life presents and the ability to make a profitable use of one's leisure time. If the scheme is to be successful these qualities must be developed in addition to the acquisition of any particular facility or any particular kind of information.

If, however, the primary purpose of the school is professional training I imagine few of us would be willing to say that a by-product, at least, of the school should not consist of the qualities which I have mentioned. I have used the word by-product because I feel that no set of subjects of instruction can claim a monopoly in the production of these qualities. Some of them will be the result of the community life which the students live. Some will be due to the personal influence of the instructor. For few, if any, will the subjects studied be solely responsible.

But assuming that the qualities which should be the result of all education are secured. a scheme of education which emphasizes professional training as its principal purpose, must seek for something more. What that something more should be is a question which I hesitate to attempt to answer. I am afraid my first thoughts are not sufficiently definite or not sufficiently based on experience to have any great value. I can only make a few hesitating suggestions based on experience in other fields. There is always great danger in any line of work that instruction in it becomes entirely academic. The instructor is always apt, particularly if his life is encompassed by the barriers of institutional environment, to get out of touch with actual life. He comes to live in a world of his own and of his immediate fellows which is quite different from the extra institutional world. In some lines of work such an attitude of mind may not be accompanied by serious disadvantages but a professional school whose instructors are of this character tends to become too theoretical. Its instruction easily becomes too didactic. Its learning becomes almost purely book learning. Its graduates find when they enter real life that they have much both to learn and unlearn. I imagine the history of engineering education will show not a few instances of this tendency towards the academic and away from the actual. Certainly this has been true of many of our agricultural colleges. I remember one case decided by one of our state courts which is illustrative. An action had been brought to take away a charter from an agricultural college because of the fact that it was using for classical instruction money given for the teaching of agriculture. The court refused—courts are always reluctant to forfeit charters—to take away the charter alleging as the reason for its action that a knowledge of Latin and Greek would assist the would-be agriculturalist to understand agricultural terms.

The same problem confronting engineering schools which emphasize professional training as their primary purposes, has also confronted the professional schools of law and medicine. Thirty years ago instruction in these schools was almost entirely didactic. In the law schools the student studied text-books and attended formal lectures. He seldom read a case. In medicine conditions were almost the same. The student read about typhoid fever and pneumonia in a book or heard them described in a lecture. He seldom, if ever, saw in his course of study an actual case of a person afflicted with these diseases. He certainly never participated in the care of patients. This has in large measure been changed. Law students read and discuss actual reported cases as a part of their regular course of instruction. Medical students receive what is called bedside instruction in hospitals attached to the schools they attend.

The problem of the professional engineering school must be solved in somewhat the same way. Laboratories may help but they will not be sufficient. For laboratory equipment soon gets out of date and with the resources at the command of most schools may not be scrapped and replaced by something new. The engineering schools will have to devise some contact with the outside world which will make their instruction real and prevent it from becoming merely academic. But that contact must be such that neither the instructor nor the student gives up more of his time to purely routine operations and processes than is necessary to acquaint him with the conditions of the world he is to enter.

Finally, even in a school which emphasizes professional training something must be done for the student which will help him in his life outside of his profession. For he is a man and a citizen as well as an engineer. As a man he must live a life which has many other than professional contacts. He will be in a world which has other than professional interests. To get the greatest profit from that world and to lead a life which is most worth while he must some time during the period of his education lay the basis for the cultivation of tastes which will enable him to enjoy non-professional things. As a citizen he must participate in the solution of problems which democracies must solve. It is true that the cobbler must stick to his last but when cobblers are called as they are in popular governments to take a share in the determination of policies they must in some way be assisted to reach right conclusions. What is true of cobblers is even more true of engineers. For engineering may be regarded as a learned profession and engineers are educated men, who may properly be called upon to share the leadership which is so necessary to wise political action. I heard the other day of a student in the Students' Army Training Corps in one of our leading universities who was asked in an examination the name of the people who inhabitated Hungary. His answer was the "McGuires." While that answer revealed the fact that the man had a basis of historical and political knowledge, yet that knowledge was so limited and imperfect that it might lead to the conclusion that he had mistaken Hibernia for Hungary.

I would not be understood as asking that the engineering student should be expected to acquire an extensive historical knowledge during his undergraduate course. With the demands made upon him by his strictly professional subjects such an expectation would be doomed to disappointment. But after all there is no reason why engineers should not be reasonably cultivated men. And for the average man the foundation for such cultivation as he is successful in acquiring must be laid in his college course.

One of the difficulties which will be encountered by those who try to lay this foundation is the reluctance which the average engineering student has to devote himself to these non-professional courses. He regards them both as useless and uninteresting. Perhaps a large measure of blame for his attitude must be laid on his instructors. Perhaps if a greater attempt were made to make these courses attractive even at the peril of having them regarded by the student as "cinch" courses greater success would attend our endeavors to coax the engineering student to consider of value the non-professional work which in his own interest he should be required to undertake.

The two problems which would appear to be as yet unsolved in the schools which emphasize professional training are thus the contact with the outside world of engineering and the cultivation of the man and citizen as well as the engineer.

The third purpose which engineering schools in general or some engineering school in particular may emphasize is engineering research. This purpose is probably the most difficult of realization. Research in pure science may without great difficulty be carried on within academic walls. It, of course, involves the expenditure of large sums of money needed for the equipment of laboratories and for the staff to which the investigation of problems is intrusted, but experience has shown that carrying on such research is not beyond the powers of educational institutions. When, however, we come to the applications of science conditions along many lines are quite different. The laboratory methods which suffice for pure scientific research are often ill adapted for the work which must be done. For the purpose of much engineering research is not so much the ascertainment of scientific truth as it is the determination of the commercial practicability of particular methods of quantity production. This purpose can hardly be realized in many cases in any laboratory which a university may be expected to provide. Engineering research must in many cases, to be successfully prosecuted, be carried on in the factory and in the mill.

There are, however, unquestionably many problems the solution of which can be begun in an engineering laboratory. There are probably some the solution of which may be completed there. So far as this is true it is very desirable that an engineering school should, if possible, devote some of its attention to their solution. For the student who thus learns to solve problems not only acquires knowledge about his profession but at the same time cultivates a mental attitude the possession of which will probably be of greater value to him than the mere acquisition of knowledge. Work of this character is even more valuable to the instructor than to the student. Successful accomplishment in this direction at the same time stimulates his imagination and makes him a more inspiring teacher. No one who has devoted many years to teaching can fail to notice the deadening influence upon his work of a persistent and continuous attention to what is known unaccompanied by some striving on his part to apply what he knows to the discovery of something that is unknown.

It may well be, therefore, that the most successful engineering schools will be ones which endeavor on the one hand to use the subjects which they are called upon to teach as subjects from which some measure of general education can be obtained and on the other to give a reasonably adequate professional training with which will be combined some attention to research. But it can hardly be expected that any school can hope successfully to do much more than to lay the foundations upon which the student must subsequently build. No engineering school, any more than a college, can expect its students to acquire all that is comprised in a general education. No engineering school, even if it devoted itself exclusively to professional training, could hope to turn out its graduates finished engineers. Nor could it if it gave all its time to engineering research hope to solve all the problems which arise in industry.

So it seems to me that the problem at the basis of engineering education is essentially the one lying at the foundation of all education, which can be carried on in an institution more or less academic in character. This is the combination of fundamentals, a reasonable breadth of view and the cultivation of the capacity to solve the new questions which are continuously presenting themselves in every line of work. Such are some of the first thoughts on engineering education which one not a member of the guild ventures to present for your consideration today.

RESPONSE TO ADDRESS OF WELCOME.

BY JOHN F. HAYFORD,

President of the Society.

Mr. President, we thank you for your words of welcome. I take it that the greatest thing a host can do is to make his guests feel at once that they are at home. By your action in immediately putting yourself on our level and starting with a discussion of the problems of engineering education you make us feel at home, and you make us feel that you are one of us and are glad to have us here.

In trying to decide where we should meet we fixed upon Baltimore and Johns Hopkins practically because we found a meeting point here, which we thought combined the elements of the North and of the South. We felt that here in Baltimore we would find some of the characteristics of the South, of its warm welcome in a social way, and we hoped—and this day starts with the fulfillment of the hope—that we would get some of the cool climate of the North.

Also early in our discussions of where we should meet it appeared that it was desirable to meet near Washington, because it was expected that the center of interest in many respects would still be Washington at this time. We did not want to be in Washington, with the distractions that are there, and Baltimore fulfilled the prescription.

This Society from the beginning has been one that was always looking for new ideas. It is quite appropriate then that we should come to Johns Hopkins, the birth place of one of the great new ideas of American university education. I am referring of course to the fact that Johns Hopkins is the birthplace of the research idea as applied to American universities. Johns Hopkins did its work so well in starting the research idea in the universities in the United States that the idea has spread to all of the universities, so that sometimes we tend perhaps to forget that Johns Hopkins started that movement.

You referred in your welcome to the fact that you have here a young college of engineering. That is another reason why this was the proper place for us to meet. As a society for the promotion of engineering education we should extend a welcoming hand to young colleges. That was done last year at Evanston, perhaps the second youngest, and this year we extend a helping hand to Johns Hopkins College of Engineering, as perhaps the youngest.

We are here, fellow members of the Society for the Promotion of Engineering Education, with an opportunity to exchange views on topics connected with engineering education. We have had a good example set already in starting promptly in that work. For the next three or four days we will be together. How well we will succeed in the mission for which we came here depends largely upon you. If we succeed, it will be because we have had a frank, energetic and earnest discussion of the problems that will come up for discussion. The success we have will depend on you individually. It will depend largely on whether you make your remarks terse and to the point—the point which then happens to be under discussion. The success then of this annual meeting is very largely in your hands. We have met with one common interest, of course, to do what we can to develop ideas that will help in improving engineering education. Of course we have come with many diverse opinions, and therefore there is a chance for lively discussion, and I hope such discussion will be forthcoming throughout all of these meetings.

RESPONSE OF PRESIDENT-ELECT.

PRESIDENT A. M. GREENE, JR.

Mr. President and members of the Society: I appreciate the honor of being elected to follow in the footsteps of so many great engineers and engineering educators who have held this office during the past twenty-five or twenty-six years.

We have all read in the papers of the bombs which have been exploded in various parts of the country, or have been placed so that they might explode. I do not know of any which was a greater surprise to the occupant of the house or to the supposed occupant of the house than the action of the Nominating Committee this morning.

I accept this nomination and election because I believe that when there is a duty to perform I should perform it. But I do it with the statement to you that I do not think the action of the Committee was fair to those who have served in other positions. I have not been an active member of the Society. There are many here today who have served faithful and well. and I think the honor should have gone to them. I did not know of this nomination before the report was read. Were it not for the fact that it would have been very ungracious and might have upset the plans of the Committee, I should surely have refused the nomination and election when this report was made.

Perhaps what I am about to state to you is a part of the politicians' scheme. The man who serves in the ward and in the county and does the work should receive the honors, and I do not feel that the Committee has acted properly in nominating me. Of course you gentlemen could not have done anything else than accept that Committee's report and have the Secretary cast the ballot. I appreciate that.

I do say, however, that during my year as President of this Society I shall try to carry on the work of the past president and the presidents of the years gone by. I can only do that, however, by active coöperation from you and coöperation from the Secretary, which I know I shall receive. He has been active in all the work of the Society. The president is to be your servant and to work with you.

I wish to express to you my appreciation of this honor, and I will try to do my best.

REFLECTIONS OF AN S. P. E. E. PRESIDENT.

BY JOHN F. HAYFORD.

The title selected for this address is purposely non-committal. "Reflections of an S. P. E. E. President" is a phrase that may be interpreted, with a mirror in mind, as meaning that your own ideas are to be thrown back to you. The address may be an epitome of what you yourselves have thought and said. On the other hand the Standard Dictionary says that "Reflection increases wisdom." In that sense of the word when an intelligent being reflects upon what he observes or hears, the statement of his reflections contains something original. The Secretary of the society, its mainspring that keeps the works going, and the assistant to the Secretary, the hairspring that attends to each separate tick, both insisted many weeks ago that I must furnish a title for this address. I am glad I made it non-committal.

After all, it is of little importance whether my reflections are of the one kind, the consensus of your thoughts put into words, or of the other kind, original. As is usual with the work of an engineer, it is relatively immaterial whether it is original or not. It is all important that it be right. I would like to help toward correct conclusions.

I have had a rare opportunity not given to my predecessors. I have presided over three successive meetings. At Evanston I found myself acting as president, without previous notice, in the absence of President Milo S. Ketchum, and had the fun of delivering his excellent presidential address,—without the labor of preparing it.

At Boston I found myself trying to bring success to a meeting of which the keynote and general plan was changed after we had come together, by the fact that our English friends with whom we were called to consult, could not stay after the first third of the meeting. Naturally the position was a difficult one.

Here, alas, at a third meeting I find myself in a difficult position. I must again deliver a presidential address and if I am to put ideas into it I must Ketchum myself.

I thank you for the privilege you have given me to help the S. P. E. E. for a year as its president. It is a high honor as well as a privilege to be the president of a society which was ''the first, and for many years the only society for the study of education in colleges'' in the United States.[1]

I thank you for your kindliness toward me during the difficult year. The past makes me feel certain that your kindliness will persist to the end of this address while we consider certain topics together.

This occasion, the Baltimore meeting of the S. P. E. E., is unique in its position in the history of the Society. We have just come out of a war which has educated us all. The war cultivated the best that was in us, and has given us new and greater ideas and ideals,—that is education. The time is favorable for readjustment in our methods in our colleges as we reëstablish our student group and our teaching staff in each institution. We have just been favored by the best objective view of colleges and engineering that has ever yet become available, the complete Joint Committee Report. Note the emphasis on the word ''objective.'' One can secure subjective views without great difficulty, but a carefully considered objective view, such as the Joint Committee Report, is not easily secured. We have it, and have it at the opportune time.

This summer with the educative war in the background, with much new food for thought, we should renew our faith and our vigor, and focus our new knowledge and energy, with new enthusiasm, on the new tasks, and on the old familiar tasks that lie before us. We should hold fast to that which is best in our former methods and add new good things gathered from our recent experience.

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[1] ''The Study of Engineering Education,'' prepared for the Joint Committee on Engineering Education, by C. R. Mann, pages 101.

Engineering is the foundation of our present civilization. Please note that I have not said that engineering is our present civilization. Civilization is the whole structure, or perhaps I should say it is the superstructure. All of those things, ideas, ideals, which men think of as civilization, are in the superstructure which could not have been built so large or so well without the foundation, engineering. The superstructure, civilization, would fall if it were not for the solid foundation, engineering,—applied science.

Look at any part of the world where there is but little engineering today, as, for example, the interior parts of Central America, away from the coasts and railroads, the interior of South America or the interior of Africa. In those places, life is for most men a struggle for the bare essentials of existence, an apathetic, listless struggle.

In sharp contrast to this, in the parts of the earth where engineering is most highly developed, the labor cost of the bare essentials of existence is greatly reduced, and man develops those luxuries which are closely related to his civilization. He has it in his power to get the bare necessities easily, in short hours. He turns the forces of nature to his own use and convenience. He travels, exchanges ideas, develops his sense of beauty and of duty, lives longer, struggles harder to go upward, develops a literature, develops social qualities, develops a religion that is based upon other foundations than mystery and fear. He becomes a civilized man, having the time and the energy to do so.

Of course, the foundation, engineering, may be used to carry some other superstructure than civilization. The Hun undertook to use engineering as a foundation for the conquest of the world. He failed because the Allies were able to use engineering as a foundation for their resistance.

The important point to keep in mind is that without the foundation, engineering, man does not have the time or energy to develop and maintain our present type of civilization. Without the engineering he cannot have the civilization. With it he has the possibility of becoming civilized, and history shows that he ordinarily makes much progress along that line.

The engineer who knows, and feels, that engineering is the foundation which carries the superstructure, our present civilization, which is something higher and better than the foundation, is naturally interested in that superstructure. He is keen to adapt his foundation to the superstructure. Naturally he is keen to see the human relations of his work and that of his profession. To him engineering is not mere technique.

Similarly the student who even dimly sees, or vaguely feels, the truth that engineering is the foundation of our present civilization is more apt than others to be permanently well motivated. He is less apt to feel that engineering is merely technique by which he may earn his way,—less apt to be narrow in his learning. He is more apt to have an impelling vision, more apt to have an interest in all that is civilization, more apt to see in the profession of engineering a glorious chance for service to mankind.

Let us not forget, even in the heat of the workday, that engineering is the foundation of our present civilization,—nor allow our students to overlook that fact.

Our slogan should be, education for service, education to bring out in each student those qualities which enable him to render greater service to mankind and to equip him with mental, moral and physical abilities for such service.

Our slogan for colleges of engineering should be, let us educate men for service as engineers.

If we adopt this slogan with the proper emphasis on the three words, men, service, engineers, we are apt to remember that each man is an organism, not a machine, that he continues to grow and change long after graduation, that we can not hope to stock him in college with all the ideas and skill he will have later, that our function in college is to help vitalize the organism, to invigorate its growth, to start it in adapting itself to its future environment. We will think less perhaps of the possible condition of that organism during the first five years after it leaves the commencement stage, and much more of the way it will be functioning in the whole period of forty years of service.

Against such a background I ask you to consider with me certain of our present oft-debated questions.

Which should receive the main emphasis, specialization or general education? The answer is, I believe, both, alternately. The most effective specialist is one who has the power and the ability to concentrate his mental pressure on so narrow a line that it is a cutting edge, who does so concentrate, and who at the same time keeps so broad a bearing on the world that his cutting edge is properly guided. The specialist who renders greatest service is one motivated permanently by a broad vision while his attention and power is concentrated on specific tasks for which he has made himself the superior of others. He needs a broad vision to motivate him and guide him to the service most worth while. The man who is broadly cultured, and nothing more, loses his cutting edge, loses his power to concentrate, fails to have the power to do the specific tasks which are parts of his service.

It has been said in our S. P. E. E. group that all general principles are built upon specific instances and the inference carried that therefore specialization is the important thing. Others emphasize the principles as all-important and seem, in doing so, to belittle specific problems or cases.

Are not both right? Is it not true that the normal procedure of the effective, alert mind is to alternate between consideration or observation of specific concrete things or ideas on the one hand and attempting to generalize on the basis of that which is common to many things or ideas on the other hand? Does not the effective thinker normally specialize a part of the time and generalize a part of the time? Should not specialization and generalization both receive emphasis alternately in our educational procedure?

Similarly, there are those who advocate strongly the presentation of theory first,—practice, concrete examples, laboratory work later. And vice versa, there are those who advocate always taking the reverse order, the observation first and the theory later. Are they not both partly wrong and partly right? Does not the man proceed normally and most effectively by alternating the two in rather short periods? He who really observes keenly soon begins to form an understanding of what he observes and develops a partial theory. If he devotes time to formulating his understanding, to making it clear, he returns to his observing with still keener insight, and sees still more that must also be studied before being understood. Such alternation is the ideal method. As there are thousands of facts always at hand to be observed and hundreds only among these thousands that carry by far the greater part of the significance, it is important in general to have one's attention focused on the hundreds by close attention to theory, to a true understanding. On the other hand, the theory needs always to be held in check, controlled, verified or destroyed by observation.

I believe that in general it is important to take each specific problem ordinarily from the theoretical side first, to sharpen the wits and the powers of observation, and then to observe and thereby test the theory, and possibly start a new train of thought.

I have been one of three who have spent much time during the war developing a new type of instrument. The problems encountered were exceedingly difficult. We worked by the method I have just outlined, by rapid alternation between theoretical investigation and observation. Our desks were in the laboratory where the experiments were being conducted. I can assure you that one who writes refined theory at a desk while behind him in the same room are others who are testing the crude form of that theory, writes with a care and keenness that is conducive to efficiency. So too I can assure you that he who observes under these conditions with the knowledge that if he has watched the non-essentials and missed the significant that a developing theory will soon detect his lapse,—

he who so observes, observes keenly. The method of rapid alternation which was followed with the prevailing emphasis on theory first, gave a rate of progress which it is now evident was much more rapid than could possibly have been made by the observation—first method of procedure. The experience has made me a still more ardent advocate than before of the method of rapid alternations with the emphasis on theory first.

I am convinced that intelligence tests have immediate value, even now, when we know so little about them. I feel certain that they will become much more valuable when they are better understood. This statement is made in order that I may be understood when I raise a question on one point in regard to such tests as applied to students of engineering.

It is strongly advocated that certain objective tests, which seem to me to be essentially vocational tests, should be used on engineering students. We are probably justified in being sceptical on this point. Engineering is not a narrow vocation and immediate success is not the important thing. An engineer, it is true, like all men, carries a routine load which may be specified in advance in some cases. But after all the valuable part in an engineer's service arises from his ability to see and solve new problems, to improve design, to meet the emergencies of operation, to put better methods of procedure in the place of the usual methods, to see the things that are not where he looks and which may be in the future only. The engineer's greatest service is based largely on his ability to see the things that are not obvious, to see the possible advances that are but obscurely indicated, to see in the blue-print and the description that which is a possible future fact worth while. The engineer who is of great service to the world deals, as a rule, with a great variety of things which may cover a large part of the whole range of science, including those undeveloped sciences which contain the laws of the reactions which occur in the contact of man with man, as individuals or in groups.

It seems to me that any candid study of many engineers who have rendered great service to the world will show that they exhibit great variety in their general characteristics. Among the engineers who have rendered great service are men of the artistic temperament, men with great ability at the fingers' ends and men with but little manual skill, men who have succeeded by direct attacks in person on the technical problems that came before them with little attention on the human elements in life and men who have worked almost entirely through other brains than their own, being great executives in the engineering field. There is still abundant opportunity in engineering for all of these types.

The engineers that we should aspire to educate have so broad a field, so great a variety of opportunity, such large powers of future expansion beyond their size while in college, and expansion in so many directions, that we should be sceptical of vocational tests or of objective tests of that type for them.

Please do not misunderstand. It is certain that there should be, and probably will be, much experimenting in the next few years in connection with various tests applied to students of engineering. It is only on one point in connection with the proposed tests that I have expressed skepticism. I believe that an engineer needs intelligence and must use it,—but not simply a particular kind of mechanical mathematical intelligence. Hence I believe that the future tests should aim to discover and measure intelligence,—rather than a particular brand of intelligence.

It is reasonably certain that some within hearing are thinking "that is all well and good if you are considering only the leaders in engineering, but how about the large numbers of men who do the routine work in engineering, the men who are draftsmen for life, who operate small power plants for life, or who are inspectors and remain so." The sooner we recognize that such men have not measured up to the standard of service which we recognize cordially as engineering, the better it will be for engineering education.

There is need of much clear recognition of the fact that the greatest defect in our educational system at present is the lack of vocational training. Trade-schools are needed,—trade-schools which are frankly and definitely devoted to training artisans of all grades, including the highest types, as for example, skilled draftsmen. The draftsman bears the same relation to an engineer that the trained nurse or the interne in a hospital bears to the surgeon. The trained nurse renders valuable service in that capacity for life. The surgeon's success is based on her skill and fidelity. The interne is for a time in much the same relation to the surgeon as the trained nurse. But he is developing up through that experience to become a surgeon. So also a good road to the engineer's position runs by way of temporary service at the drafting-table.

If we had well-developed, frank trade-schools. many of the best men for the routine work which is the basis of engineering would be developed in those schools. and probably the draftsmen would largely be developed there. As a result we would have better workmen, better foremen, better operators, better draftsmen. As artisans of higher grade were developed in such a well-planned system of trade-schools we would be face to face in time with even greater difficulties than now in drawing a clear, definite line to separate the highest grade of artisans from the engineers. The engineers would find the emphasis in the lines in which they served going more and more to the creative side, the improvement side. The engineer's education would in time respond still more than at present to that kind of a demand on his ability.

The establishment and frank development to their highest capabilities of trade schools for artisans would give the graduates of such schools better preparation for their future service in a shorter time than they can now get it, either by experience merely or by studying to be artisans in a college of engineering.

Permeating many of our educational problems in this society are obscurities that arise from the fact that the essential difference between the high-grade artisan and the engineer is not clearly seen and the corresponding action taken.

In military life everywhere a clear distinction is seen between the private, or non-commissioned officer, and the officer. That distinction clearly seen and acted upon is effective both in contributing to the efficiency of the organization and in developing the individual in it.

As in military life, the exceptional men frequently pass from one of these classes to the one above, from the non-commissioned to the officer class, so we should expect even though we had the ideal educational system, that exceptional men, trained as artisans would rise to the professional class. The point is that both the education and the performance would be improved by recognizing frankly both classes as distinct, just as it is certain that in the Army and Navy frank recognition of the officers and of the non-commissioned officers as being in distinct classes contributes to raising the quality of their service and of their training.

During the war it has been impressed very strongly upon our attention that under the spell of a nation wide unanimous purpose our young men were so strongly motivated that they showed powers much greater than we had supposed them to possess. Every young man had an abiding fierce determination to fight the Hun. He was ready and willing to take any discipline or do anything required that would help him along the line of his determination. When he saw his chance in the form of a specific task,—as a motor mechanic, an aviator, or a radio expert he took the essentials of that specific training with most astonishing vim and rapidity.

It is important that, as educators, we should see the meaning of this experience in true perspective,—that we should not draw false, or unbalanced, conclusions from it, as we attempt to apply war time experience to times of peace. We have had the strictly military view of the matter presented to us very fully and very vigorously, during the war, and at this meeting.

I desire to raise and emphasize three broad questions arising out of the war experience. First, In the next ten years in our colleges of engineering will the successful motivation of our students be a military motivation, or a motivation in some other line? Second, Is it possible to get a real speeding up in the education of engineers in time of peace that shall correspond to that which was secured in the training of men for specific tasks in war time? Third, Is it our patriotic duty to train all, or large numbers, of our students to be military engineers? Or will we serve the nation still better if we educate them thoroughly as engineers and let them get at college or in camps whatever small amount of the essentials of strictly military knowledge experience may show each man should have,—but get it without interruption of their engineering education or distortion of that education.

Our young men under the spell of the unanimous determination to fight the Hun had an extremely strong military motivation. Did that motivation show a sudden lapse when the armistice was signed? Are the young men now in college showing the intense motivation toward military occupations that they did in 1917 and 1918? Should they show such a motivation now if they see things rightly? Is the task now imminent before us in the world essentially military,—or essentially a peace task? Consider the mental attitude of the boys now in college. Do they take to military training with avidity? Is not the military motivation for engineering students largely a thing of the past? As motivation is extremely important to our success as educators should we develop a new motivation in the place of the lost military motivation,—or take advantage of whatever motivation now exists in nascent state in our young men? A frank and full consideration of these queries will also furnish a true answer to that first question, which was "In the next ten years, in our colleges of engineering, will the successful motivation of our students be a military motivation, or a motivation in some other line?"

Next, Is it possible to get a real speeding up in the education of engineers in time of peace that shall correspond to that which was secured in the training of men for specific tasks in war time? Education is essentially a slower process than training. The more specific and narrow the task for which a man is to be training the more quickly he may be trained. Each piece of war time training was purposely and rightly made as specific as possible. An engineer needs an education which shall fit him for a large variety of somewhat vague tasks. To train a man to do things at once thus and so,—is an undertaking which lends itself readily to a speeding up. But it is a much harder task and one which is essentially much slower, to educate a man so that he will think. That is what we must do for our future engineers. Let us keep these things in mind, and apply the necessary correction factors, whenever it is tacitly assumed, or openly asserted, that the war experience in training for specific tasks with great speed shows that we may educate engineers in a much shorter time than we have in the past. Of course we can do better than we have in the past,—but education cannot be speeded up to the same limit as special training.

In discussions as to possible changes in our educational system one tacit assumption frequently made is that it is our patriotic duty to put much of a military complexion into our training of engineers, that it is our patriotic duty to pay considerable attention to military engineering in the training of engineering students. I challenge that assumption. I believe it to be clearly a mistake and have indicated my belief in the third question,—"Is it our patriotic duty to train all, or large numbers of our students to be military engineers? Or will we serve the nation still better if we educate them thoroughly as engineers and let them get at college or in camps whatever small amount of the essentials of strictly military knowledge experience may show each man should have,—but get it without interruption or distortion of their engineering education."

In the war just ended the original engineer arm of the United States Army was increased to 131.5 times its pre-war strength. Eleven per cent. of our total force was made up of engineer troops. On the face of it this means that as a patriotic duty we should train an extremely large number of military engineers. But is that the correct conclusion? The expansion was made by taking men educated for engineering, and with experience as engineers in practice, for officers, and using for the rank and file in engineering troops, artisans in engineering lines with a peace time occupation similar to that which was to be theirs in war. It was found to be both an easy and a short task to give them, the officers and the men, the essentials of strictly military knowledge. They did their war work well and promptly. In general throughout this war, in so far as the United States was concerned, the greatest shortage was never in trained officers and men. It was in transportation and materials. The higher the development of engineering in peace time in a given nation the more quickly these shortages of transportation and of materials can be met. Our engineers in war faced the same problems as they had been accustomed to in times of peace. If we train our future engineers to solve the problems of peace more thoroughly we will be doing much more to increase their effectiveness in war than by giving them in advance a little smattering of so-called military engineering. The great principles of military strategy remain the same throughout all ages. But the tools and the tactical methods of war change each generation with the advance of applied science and are conditioned on the state of that advance. We as engineering educators shall contribute more to the national welfare by raising the state of the art, engineering, than we can in any other way.

In the process of doing our best for engineering by improving engineering education while we hold fast to that which is excellent in our present methods, we should of course welcome any enrichment of courses and improvement of methods which may come from our military experience or our military arms.

Our greatest service to the nation will be to do our best to make this nation foremost in engineering in time of peace,—and therefore foremost in military engineering in time of war when, and if, war shall come. Our service will be of the highest type if there is ever before us the realization that engineering is the foundation of our civilization,—if we realize that we make a better superstructure possible when we build the foundation better,—if we realize that our part is ever to foster a better, broader, more thorough engineering education than has ever yet been given.

THE CASE SYSTEM FOR THE STUDY OF LAW: WHAT IT IS, AND ITS BEARING ON ENGINEERING EDUCATION.

BY C. F. ALLEN,

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For a proper understanding of this paper it will be necessary to understand what is meant by the term Law. The study of law is essentially the study of the common law, so called. It should be understood that the basis of the common law is right and justice, and that in business matters custom often determines what is right and just.

When individuals differed as to right, courts were resorted to for the purpose of securing an unprejudiced decision as to right. For a time there was a chance that one court might judge one way, and later, another court another, where the matters involved differed inappreciably, if at all. Afterwards, as a business necessity, it became the habit that the decision of a court of sufficient importance should be recorded, and further that the decision of a court so recorded, should be given great weight (or even allowed to control the decision) by another court when the same or an analogous case came up. The decisions thus rendered are found in the "cases" reported and it is customary now to print and bind the reports of cases decided, so that they may be available to lawyers for use in court to sustain their contentions as to matters of law in future trials.

The decisions thus recorded become the law and the common law rests upon these decisions and the principles which may be derived from a study and comparison of them.

Treatises have been written, in many cases by very able lawyers. oftentimes by distinguished teachers of law, arranging and stating the principles involved in these decisions, working out systems applicable to various subjects such as contracts, torts, equity and many others. Such treatises are of great value, partly because through them, it becomes unnecessary for each lawyer to duplicate the work of harmonizing decisions and establishing the principles involved. Furthermore, not every lawyer has the analytical ability to do the work as well as the writer of the treatise.

However valuable these treatises are, they do not have the weight of law. The court may attach great importance to the opinions of the lawyer who wrote the treatise, but the law is to be found only in the decisions of the cases. Very strictly it is accepted that the "decisions" only of the judges are law; the reasons they give are not law. An eminent lawyer and writer, Bishop, has stated: "The nature and function of a judicial decision is the conclusion of a judicial mind upon particular facts. A controversy between parties had arisen, and to settle it they brought the facts to the tribunal and proved them; thereupon it pronounced the law's determination upon those facts, and it did nothing else."

The situation will be understood if it be stated that a decision which is really right and sound will stand, if reviewed by a higher court, even if the reasons given are unsound.

As a matter of fact, the reasons given illumine the decision and make it understandable, and the influence of the reasons given has probably been greater than that of the decisions themselves. It has been well stated by Prof. John C. Gray, of the Harvard Law School, a well-known practicing lawyer as well: "The highest courts have always deemed it their duty not merely to advise, but to announce publicly the grounds of their decision." "The judges therefore . . . have furnished to the profession and the community the principles of law as well as judgments in particular cases. A principle would be laid down in one case very imperfectly, another case would extend it in one direction, a third restrict it in another, a fourth modify it, and while there has been no expectation that the judges would deliver essays on the law, it has always been deemed proper and right that they should state the principle as extended, restricted or modified, in accordance with which they decided the case before them."

In many newer cases brought to trial it is found that no new principle is involved, and the decision rests substantially or absolutely upon some case previously decided. Certain cases frequently used in this way have become known as "leading cases."

Early in the operation of law schools in this country, the instruction was given, so far as class work was concerned, by lectures, and treatises or "text-books" were used to enable the student to study closely the principles in various branches of law, outside the lecture room. The treatises referred to cases which might be read if the pupil desired.

When Professor Langdell was appointed dean of the Harvard Law School in 1870, the course covered one year and a half of work, the instruction was largely by lectures, and there were no examinations. No wonder that he saw the need of something better!

Engineering colleges have found that theory can be taught to the best advantage only in connection with its applications. It does not seem strange that Langdell reached a similar conclusion. The decisions of the courts which are the underlying sources of the law, are found in the reports of the cases. These reports include a statement of the essential facts; of the issue, which is the matter in controversy legally, reduced to its lowest terms by the pleadings of the lawyers; the decision of the judge upon this point, in favor of the plaintiff or the defendant; and the reasons for the decision, generally held not to be law, but an expression from a high source of what the judge conceives to be a principle of law applied to this case.

In a treatise or text-book, the student finds principles or rules of law set forth as developed by the author from his study of the cases. These principles are there largely dissociated from the facts and issue of the case. In the case system, the pupil studies the cases, and his duty is to discover the principle or rule of law which, in this instance, will be directly associated with the facts. The theory and its application are here brought together.

Langdell further advanced the proposition, rather necessary to justify his method, that:

"Law, considered as a science, consists of certain principles or doctrines. To have such a mastery of these as to be able to apply them with constant facility and certainty to the ever-tangled skein of human affairs, is what constitutes a true lawyer; and hence to acquire that mastery should be the business of every earnest student of law. . . .

"Moreover, the number of fundamental legal doctrines is much less than commonly supposed; the many different guises in which the same doctrine is constantly making its appearance, and the great extent to which legal treatises are a repetition of each other, being the cause of much apprehension."

He evidently appreciated the fact that a qualitative "understanding" of law is more important than a quantitative "knowledge" of law. Statute law, reversals, or newer extensions of principles often undermine what is merely "knowledge of law."

Another feature of the instruction, which may more properly be called Langdell's system than the case system has not always attracted the attention it deserved. It appears to the writer to lie at the root of the success of the "case system" (Langdell's system) at the Harvard Law School.

Quoting Langdell: "It was necessary, first, that the efforts of the students should go hand in hand with mine, that is, that they should study with direct reference to my instruction; secondly that the study thus required of them should be of the kind from which they might reap the greatest and most lasting benefit; thirdly, that the instruction should be of such a character that the pupils might at least derive a greater advantage from attending it than from devoting the time to private study."

Again, "I wish to emphasize the fact that a teacher of law should be a person who accompanies his pupils on a road which is new to them, but with which he is well acquainted from having often travelled it before."

The system of instruction adopted as being well adapted to these purposes, was neither lecture nor recitation but a well-considered conference or discussion into which the teacher and pupil entered upon substantially even terms. The teacher assumed the position of leader rather than instructor, all working together in research, seeking for the truth, groping for the truth more often perhaps, and floundering not a little. The teacher subordinated himself, helping, rather than directing. The instrument was a corkscrew rather than a ramrod, and yet not the stomach pump of the recitation. In its actual workings, the pupil appears to have forgotten to regard his teacher as a common enemy; the teacher refrains from dogmatism; the exercise is very democratic. The fact that the pupils at Harvard Law School are graduate students makes this attitude more readily possible.

Doctor Redlich, professor of law at the University of Vienna, after investigating the case system for the Carnegie Foundation, in describing the system of class work, says:

''Langdell began his teaching by having each of the cases, which the students had to study carefully in preparation for the class, briefly analyzed by one of them with respect to the facts and the law contained in it. He then added a series of questions, which were so arranged as gradually to lay bare the entire law contained in that particular case. This stimulated questions, doubts, and objections in the part of individual students, against whom the teacher had to hold his ground in reply. Teacher and pupils then, according to Langdell's design, work together to extract from the single cases and from the combination or contrasting of cases, their entire legal content, so that in the end those principles of that particular branch of the law which control the entire mass of related cases are made clear. The two ideas together suggest and are sufficiently well described by the term 'Socratic Method'—an expression which was indeed early employed by Langdell and his pupils.''

He goes on to describe the class work:

''The students study thoroughly a number of cases at home and strive to master the actual facts involved as well as the rule of law; usually they prepare a very brief abstract of each separate case, which they bring with them to class. In the actual class exercise the professor calls on one of the students, and has him state briefly the content of the case. Then follows the interchange of question and answer between teacher and students; in the course of the discussion other students are brought in by the teacher, and still others interject themselves in order to offer objections or doubts or to give a different answer to the original question. The whole exercise generally moves quickly and yet with absolute quiet and with undivided attention on the part of the class. It must indeed make a strong impression upon every visitor to observe, as, for instance, in the Harvard or Columbia Law School, classes of 100 to 150 students engaged in this intensive intellectual work; all the students intent upon the subject, and the whole class continually, but to a certain extent imperceptibly, guided by the teacher and held to a common train of thought. The thing that specially impressed me was the general intense interest displayed by the whole class in the discussion, even by those who did not take part in it themselves; I do not remember that a student, when called upon, was confused or unable to reply, although of course not all gave an adequate answer. The transition from one case to another followed quickly, and indeed in general the tempo is a rapid one, and always only the matter in hand is discussed and superfluous generalities are avoided. Digressions from the theme are as a rule dismissed by the lecturer with a short remark; pauses seldom occur, for if the professor notices a general lack of understanding of the case, he then interposes with a lengthy explanation. The great majority of the students make notes during the course of the discussion. I looked at many of these note-books and found in them the principles of the case jotted down, almost always briefly but intelligibly, and for the most part in ordinary long-hand writing.''

After referring to certain teachers, he states:

"Other profesosrs, among whom are many of the strongest representatives of the case method, abstain from any summary résumé of the discussion, and even scrupulously avoid in any way formulating the result for the hearers, or presenting to the students their own view of the legal principles of the case. And this occurs, as I have learned from many conversations with law teachers, as the result of definite convictions in regard to method. They feel that the case method, correctly understood, ought to avoid any dogmatic instruction of the pupils by the teacher."

From the "Centennial History of the Harvard Law School" is culled the following extract with relation to Prof. James Barr Ames, a rare teacher to whom is due, to a greater extent than to Langdell, the perfecting of this system of instruction. It sheds light upon the system and is as follows:

"Ames was a born teacher; and no one who has ever been connected with the school, as his colleague Professor Gray has said, had so happy a faculty of making students think for themselves. He loved to teach, and he was a masterful teacher. He would bring out an idea, and the idea would seem entirely reasonable. He would bring out another idea, and that, too, would seem entirely reasonable. Gradually, it would dawn on the student that the two ideas were quite inconsistent and that he must decide which was right. The student was interested, stimulated, tantalized. The lectures by the Dean (Ames) especially in the course on trusts, caused great mental disturbance, not to say anguish. He baptized men in brain fire. He was the ideal teacher, courteous and patient. If he led the student to the brink of a precipice, he did not let him fall over; he never failed to indicate the path back to safety. Modestly, in all discussions, he placed the student on his own level; both, apparently, were groping in the widerness for the truth; and while he would give possible clues, he was ever ready to discuss the student's suggestions and to follow them until it became apparent to the whole class that they led only to confusion. Then, through further questioning, he gradually disclosed the true path to the light. And if, at times, one or the other man wandered away from the leading and opened up new roads to the goal, his acknowledgment was as quick as it was hearty. He aimed not so much to impart information, as to develop the analytical powers of the men, to make them think as lawyers. He questioned much; he answered little. Those who came to hear the law laid down went away to ponder what it ought to be. He loved the battle of wits; but he never argued for the sake of victory. He helped men in many ways, but most of all because he made them help themselves. It is a great deal easier for a teacher to state his own views to students than to get them to think for themselves. His views of the law were very positive, but he always kept them in the background until he had got the students to exercise their own minds on the problem.

"It was his singular patience in this discussion of legal principles with his colleagues that has created at Cambridge what may fairly be claimed to be a school of legal thought as well as a law school.

"Ames was fitted as few are for original research, endowed with unrivalled power in extracting sound principles from the bewildering maze of decisions, and skilled in the highest degree in generalization. He never practised at the bar, and was a legal philosopher rather than a lawyer."

With a treatise or text-book as a basis, it is almost as natural for a pupil to depend upon memory as it is for a duck to swm. With the system of conference and discussion the pupil is called upon to think, to reason, and at short notice; and with the case book as a basis, to reason legally. With some of the present professors, the program is something like this: "Mr. Smith: Case of Jones *vs.* Brown, page 157"—(Facts and decision are stated by the pupil.) "Do you agree? "Supposing?" (A variation in the case.) "Supposing again?" (Another variation.) Others in the class are appealed to, and in time a legal principle or rule is evolved. The thinking and reasoning are in the class room, and memory cannot be substituted.

Strictly, if the court's decision only is law and the reasons not law, a principle can no more be derived from one case, one decision, than the direction of a line can be determined from one point. Two points will serve to fix a line if the points are theoretically or mathematically determined. Where an empiral line is to be determined, a series of points are necesary, sufficient in length and within whose limits as to breadth the line must lie. The principle of law is held to be empirical. In its purity, with the case system, several cases must be studied together in order to determine the limits within which the principle or rule must lie. The full benefit of the class room exercise is secured from considering a group of cases, rather than from discussing a single case only.

In the practical application of the conference and discussion system at the Harvard Law School, the pupils appeared to the writer, as to Dr. Redlich, to be alert and interested even in classes of one hundred or more. As a graduate phrased it, "They are on their toes all the time." The exercise is fascinating to the visitor if he knows something of law, so that he can follow.

In the opinion of the writer, the conduct of the classes is the distinguishing feature in the success of the "case system" at the Harvard Law School. In another law school which the writer happened to have an opportunity to visit, a "recitation," called by that name, was in progress, and there was an almost complete absence of the interest, enthusiasm, and attention characteristic of the Harvard classes. The basis of the recitation was, however, a number of cases assigned from a case book. A few students who were called upon doubtless derived considerable profit, but this recitation would not meet Professor Langdell's test that "the pupils might at least derive a greater advantage from attending than from devoting the time to private study."

It has been stated to the writer by a prominent educator, long connected with Harvard University, and who is also a member of this society, that the success of the "case system" at Harvard is due largely to the able teachers who have administered it. There ought to exist no doubt of this. In the selection of cases to comprise the case book, much knowledge of law and skill in arrangement are essential in order to secure a progressive development of principles. In the conduct of a class to secure the atmosphere which undoubtedly does exist at the Harvard Law School, a nice touch is important, and with a class of one hundred "on their toes all the time," the teacher's work surely is cut out for him. While this is true, nevertheless the case book apparently gives better opportunity for the fine teacher to lead his pupil to reason rather than memorize, than does the law treatise or text book, and perhaps than any other basis for instruction in law or otherwise. The Langdell system of class work also gives special opportunity for the good teacher to do superior work.

It appealed to the writer that it was wise for him to take a leaf from the Harvard Case System, by attending not one exercise, but several in an attempt to discover from a series of observations principles underlying the system practised there. He attended fifteen class room exercises, covering fourteen subjects, under nine different teachers. It goes without saying that the teachers were not all of equal skill; the average was high, and there were a number of superior teachers. The detail differed, as might be expected, with different teachers, and with the same teacher in different subjects, as is proper, and it was freely stated by a prominent member of the faculty that the year of the class, the advancement of the pupil, also affected the character of exercise. One very able teacher, regarded by one of the pupils as the "most brilliant" of his teachers, conducted an exercise in one subject almost as a recitation, and in another subject did nearly all the work; nevertheless the momentum of the Langdell system of class work, served to maintain the attitude of working together and to sustain the interest. To avoid any chance of conveying a wrong impression, it appeared to the writer that both exercises were conducted with excellent judgment and skill.

It is also a tradition that with another of the professors that there is much floundering in his classes, but one of the pupil's criticism of this was commendation, not condemnation; he "liked it." When another professor's name was mentioned a pupil tersely suggested "Supposing." Of another, a younger professor's class exercise, it was remarked, "That was a pure lecture." One able professor discouraged the writer from attending his class because he was to "lecture" upon a chapter where no preparation had been assigned. It proved to be well worth while to attend. A question here and there gave the exercise an unusual flavor, and upon a protest, after the lecture, from the writer that it had hardly been a lecture of the college type, the professor remarked that if he lectured only, for full hour, his class would go to sleep.

It seemed apparent to the writer that with pupils trained in the Langdell Class System, variations toward lecture or toward recitation, or class work which had some flavor of routine at the hands of a teacher less experienced in the system, none of these had the effect of bringing the attitude of the class to that ordinarily existing in lecture or recitation.

The pupils, as already stated, take notes freely of the points or principles developed by the discussion. These notes are preserved and sometimes used even after graduation and admission to the bar. They are also necessarily studied as a preparation for future class exercises. The case books have a progressive arrangement. and the class work requires the application to new cases of principles already established as well as the derivation of principles from the consideration of a series of cases.

In starting and developing the case system and the Langdell class system, the Harvard Law School was fortunate (or wise?) in its professors: Langdell, who originated the scheme; Ames, who more than any other perfected it; and with them John C. Gray and James B. Thayer.

Of Professor Gray it has been said:

"Even after Langdell and Ames had made the case system a success, Gray long continued his own method, not requiring students to state or discuss cases, but announcing a list of cases to be read as a preparation for each lecture, and then giving a lecture of artistic form, with beginning, middle, and end, but with occasional questioning.'' ''Gray eventually became a convert to the case system at the time when Langdell's method was meeting with much opposition among practitioners.''

A former pupil of Professor Thayer has said of him:

''I have always thought his analysis of a case more exact and complete than that of anyone else I ever knew. He never found more in a case than was actually there, and nothing that was there escaped him. . . .

''Few can have attended his lectures without learning more than the legal doctrines which were the direct objects of their study. Something—at least of the accurate and careful habit of mind, the patience in wearisome investigation, the absolute intellectual sincerity, the never-failing kindness and courtesy which distinguished the teacher, must have borne fruit in the minds and hearts of the pupils.''

Commenting upon the case system, Professor Gray has said:

''It is not a system which will work itself, but neither will any other system. . . . With a drone as a teacher and a dunce as a student, the study of cases would not be the surest method to get into the bar.

''I ought also to say that the employment of the 'case system' involved a certain amount of time; and although the law is, I think, most solidly and permanently acquired in that way, I doubt if it could be used with full effect in a course of less than two years. The course necessary at Cambridge is three years.

''Legal treatises have their value, to the judge, to the practicing lawyer, and to the student. It is well to have the intelligence and the industry of able men extract and develop the principles of the law in scientific treatises, as it is well to have the intelligence and industry of able men extract and develop in systematic treatises the principles of chemistry or mathematics.

For the pupil or for the engineer who desires to acquire a general knowledge of law and an appreciation of the scope, the case system appears to be uneconomical of time. Few pupils or engineers would profit suitably from a study of cases without a teacher. Furthermore, with this system, unless the teacher is a master of the subject he is teaching, some harm even may result to the pupil from unwise leading, on the principle that "a little learning is a dangerous thing." On the other hand, a student may readily acquire from a suitable treatise or text book a good general understanding of law without any teacher, or with a teacher whose knowledge of law goes little beyond the scope of the treatise used as the basis of his teaching.

These remarks should not, and cannot properly be considered an adverse criticism of the case system as practiced at Harvard, for which the writer professes great enthusiasm.

It is reasonably certain that the average student can obtain a knowledge of law sufficient to pass his bar examination in far less time from text-books than is necessary following the case system. Students who have fallen behind at the Harvard Law School use text-books in preparation for their Harvard examinations. Their use by pupils there is, however, said to be uncommon. It is easy in matters studied in the treatise or text-book for the memory to be "like a sieve that lets most of what was poured into it run out again," although there are good minds which easily assimulate principles as principles rather than as memorized facts.

The purpose of education in law is not, however, to enable a young man to pass a bar examination, but to train him thoroughly for his work. Quoting Professor Gray again: "There are two things to be acquired in a legal education. First, the knowledge of a certain number of facts. Secondly, the habit of correct reasoning on legal questions, with a ready and accurate perception of legal analogies, and the second is much more important that the first."

As to the success achieved at Harvard in this way Dr. Redlich remarks in his report:

"I visited particularly classes of the third year, in which difficult cases, as for example cases involving a 'conflict of laws,' were analyzed by the students with great readiness and grasp of the subject-matter; classes in which there stood out strongly not only excellent logical training, capacity for independent study, and especially for quick comprehension of the actual point of law involved, but also indisputable knowledge of positive law. I gained the impression that law students of the third year in our European law schools would hardly ever be found competent for such work. On the other side, however, I am just as positive that, if all first attempts are difficult, this is especially true of legal education according to the case method. Eminent professors of law have repeatedly explained to me that it takes a long time before the excellent effects of instruction by law cases are evident. The beginners are, as a rule, rather confused by what is demanded of them in class, and usually for a considerable period only the particularly quick or talented students take part in the debate; but after some weeks or months, things become clearer to the others also; the students begin to grasp what it is all about, and there soon follows the hearty coöperation of the majority."

Some of the pupils stated to the writer that it takes two or three weeks before they get proper hold of the system. Two or three weeks as a foundation for continuous intensive study along the same line for a period of three years is not lost time. The system, like a snowball, gains as it rolls on.

But two weeks of eight hours a day means 96 hours or more. Many an engineering course has only 30 class hours with 2 hours' preparation for each, or 90 hours in all. A course in business law might be so scheduled. Would the case system be economical for a short course of this sort?

Professor Keener, of Columbia University, an uncompromising advocate of the case method, says for the representatives of this method:

"The system produces a lawyer more quickly than the text-book system, for the reason that, in their opinion, the powers of analysis, discrimination and judgment which have been acquired by a study of the cases by the student before graduation must be acquired by the student of the text-book system after he has ceased to be a student and has become a practicing lawyer.''

He further states:

''The student is required to analyze each case, discriminating between the relevant and irrelevant, between the actual and possible ground of decision. And having thus discussed a case, he is prepared and required to deal with it in its relation to other cases. In other words, the student is practically doing as a student what he will be doing as a lawyer. By this method the student's reasoning powers are constantly developed, and while he is gaining the power of legal analysis and synthesis, he is also gaining the other object of legal education, namely, knowledge of what the law actually is.''

Redlich refers to a later ''conception of the purpose of legal education as a whole; to the conception, namely, that the real purpose of scientific instruction in law is not to impart the content of the law, not to teach the law, but rather to arouse, to strengthen, to carry to the highest possible pitch of perfection, a specifically legal manner of thinking.''

How many among us have a materially different conception of the purpose of engineering education; not facts, not knowledge, but scientific training, training for power?

Is it, or is it not true that our engineering colleges are successful in leading the pupils to think rather than to memorize, to think mathematically, scientifically, or if you please engineeringly? Isn't there a chance that some of us may go astray, from idolatry of the ''case,'' losing sight of the system of class work and the skill of the teacher, if these are the real features which make the case system a success, as appears to be true?

Does it follow that the system best adapted to the empirical study of law should be the one best fitted to teach students to think analytically and logically in engineering subjects?

Is it or is it not desirable to use text-books in teaching algebra and geometry, and mechanics, and its extensions in structures? With good teaching, can students successfully memorize in these subjects? Are they not required to think, and to analyze, to reason mathematically?

Are we really taking a leaf out of the case system if we assume a "dynamo as a case"? Isn't a case (or cases) the source of the legal principle, while the dynamo is derived from the theoretical principle rather than the reverse? Are the instances analogous?

But the "case system" clearly has been a notable experiment as a system of education. It is not wise for us to see, if we can, how much of the system is applicable to engineering education?

What are its commendable features?

First, the study of cases is but the beginning by the student of the kind of work he will continually do as a practicing lawyer. In how many subjects of engineering can a similar practice prevail without sacrificing training value? How in a course in chemistry? How in a course in physics?

Second, the Langdell method of class instruction by conference and discussion is well adapted to secure the attention and interest of the pupils and to lead to clear thinking and sound reasoning legally, and to secure a splendid training. Many of us have used something like it to a greater or less extent, and advantageously; probably none of us as perfectly as is readily possible in the law school or as developed at the Harvard Law School. Cannot those of us who have tried it, use it to a greater extent? Cannot those unfamiliar with it, gain in teaching efficiency from using it? In what subjects is it readily available and in what apparently inapplicable?

Third, the student, in studying cases, reads not only the decisions, but also the reasoning and exposition of legal principles by the judge. He is imitative and unconsciously, perhaps, puts himself in the position of the judge, and so acquires to a considerable degree the point of view and attitude of the judge. He acquires gradually the legal attitude. He does the same in a degree with relation to his teacher.

Has this advantage a ready parallel in engineering education? Does the engineering teacher realize the influence he unconsciously exerts upon his pupil in ways not directly involved in his teaching?

Fourth, the judges have been selected as men of ability. It naturally becomes their habit in their decisions and their reasoning to exercise special care in using clear and logical statements and language. The student doubtless gains as a student of English in clarity of thought and written statement.

Does engineering education offer similar opportunity? Should the teacher do what he can in this direction by cultivating clarity of statement before his classes?

Fifth, an English teacher of law, Finch, has stated of the case system:

"But there is another element in legal education which distinguishes the law from other branches of learning. That element is speech.

"We must encourage the practice of oral discussion; we must revive speech.

"If you accustom the student himself to analyze facts and opinions and arguments in search of rule or principle, if you accustom him to state facts, to formulate his ideas with facility in answering questions, if you encourage him to argue debatable questions of law, you supply most efficient means for forming and developing the powers of his mind."

Is it not possible to do more than is commonly done in engineering colleges to accustom pupils to the practice of standing upon their feet, thinking clearly and putting their clear thoughts into words, tersely, logically, and clearly expressed? To what extent can the teacher of structures or other engineering subject use the time of his class in insisting upon statements correct in form? Is the necessity as great as in a law school where the form of statement may be the essence of the law?

A case system is in use in Harvard Medical School in a half dozen or more of subjects. The case there is a statement of the history and the symptoms of a patient. The

"Socratic Method" of discussion is used to determine the diagnosis and treatment. It appears to be a suitable and desirable method of instruction.

One of the professors of the Harvard Law School was called upon to teach soldiers in military tactics. Problems served as cases; physical, topographical and military data constituted the facts; and the conference and discussion method of teaching was found appropriate and successful, as might be expected.

It is doubtful, however, if either of these offers opportunity for as perfect a use of the case system as is provided by taking law cases as the basis for instruction.

With these illustrations available, may it be asked, what is a "case"? Is not a case a series of facts or conditions constituting a source from which a principle or line of action is to be developed? Is not this true of a legal, or a medical, or a military case? In what other directions do cases exist suitable for profitable use in education? In how many engineering subjects does such a case readily exist?

It should further be borne in mind that Langdell delayed putting into force his scheme of teaching for a year and a half until he found time to prepare his case book. In the Medical School case books are already prepared. In the military school a book of problems was in effect a case book. Will a case system be possible in an engineering college without a case book? Who will prepare one?

The writer has been sufficiently impressed with the Langdell class method, so that it has seemed to him more appropriate in this paper to raise questions rather than record dogmatic opinions. The members of this society will doubtless prefer to do their own thinking in any event. Why not directly encourage them to do so, and to find means for the use of this, or indeed of any other promising method of class instruction?

Discussion.

F. P. McKibben: In teaching structural engineering the Case System is a good one. It is most suitable to teachers of experience; but it can be used by younger teachers, provided they be properly supervised by the older ones.

There is another phase of this question in which we are interested. Many of you gentlemen are practitioners, and serve before courts as expert witnesses. And I think you have been probably impressed by this fact, that the present method of selecting engineers is not conducive of the best results. Each side selects its own engineers, and each side usually presents its own view. Would it not be better for the court to select the engineer and let the latter present the facts to the court and to the jury as an unbiased opinion?

A. L. Williston: I think we are greatly indebted to Professor Allen for this extraordinary interesting description of a very important type of education, and one that has been called to our attention as a possible guide for us in the Mann Report.

I think the description which Professor Allen has given us of the way in which the Case system is made to inspire the young men in the Harvard Law School, and in other law schools, to learn to think with precision inductively is very valuable. I am certainly greatly indebted to him.

There is one point in which Professor Allen raises a question I would like to speak of for just an instant. Professor Allen, as I understood him, referred to these young men as thinking clearly and accurately, and then a moment later referred to the men in our engineering schools as thinking clearly and mathematically, as though the process of thinking, to make the thinking, in the two instances was the same. To my mind there are diametrically opposite mental processes in the two instances—the process of thinking inductively from a mass of facts as we find them in nature, from which we must deduce by induction laws and principles, and the method of thinking deductively from things as assumed actions to logical and definite conclusions, are quite different.

Another point that seems to me is worth mentioning, and that is when the so-called laboratory method was introduced into American education a great deal was made of the importance and the value of training in inductive thinking. Much of what President Rogers of the Massachusetts Institute of Technology said regarding the system of education which he started was related to this inductive system of reasoning—the Case system, the reaching out for the facts, and from those facts deducing principles by the process that Professor Allen has described in the Harvard Law School.

The question which really seems to me is very serious before us as a Society is this: In the actual practise of engineering as it is practised by the majority of men, is in the main, the kind of thinking required of engineers. Is it the deductive thinking of the mathematician, or is it the inductive thinking of the physician who has to diagnose his case, the lawyer who, from a mass of facts which appear on the surface conflicting, has to deduce proof? It seems to me personally from my own experience that there are two cases perhaps in which inductive thinking is required to one in which deductive thinking is.

The real question that this charming paper brings before us, it seems to me, is the question of whether we have as large a proportion of the real laboratory method of instruction by means of which the trained men would think inductively as there is found in the conduct of their practise later.

Frank J. Goodnow: Mr. President. I do not think that I can contribute much to the discussion so far as it involves the ability to transfer this method to engineering education.

I have taught law under the Case system, and I have taught law under the system of recitations and lectures. Now, when I say I taught law perhaps I ought to make a qualification. My particular work was in public law, having to do with constitutional law in the main, and I believe it was Professor Gray of Harvard, who after Professor Thayer's death took up the teaching of constitutional law by the Case system or method, and who finally abandoned it, saying that constitutional law was not law, it was politics. So that I perhaps am not as well qualified to speak of the Case system as a good method of imparting instruction in purely legal subjects.

But I know this was my experience, and that is that the interest in the recitations upon the part of the students was very much greater where cases were used and where they were not spoon fed on lectures. There was not any doubt about that. The boys were all interested; they were on their toes. And I personally would never try to teach even that so-called branch of the law, constitutional law in any other way than by the Case method.

Now, I was interested very much in all of Professor Allen's paper, but I was particularly interested in his endeavor to discover what would be the "case" in engineering. Upon that point I cannot contribute anything because I do not know enough about engineering instruction; but I think the thing that interested the student in the Case system in the study of law was the fact that there were these concrete things, these relations in which individuals can enter which were brought to their attention, and the law was made absolutely real to them. It was a part of the life in which they lived, and the interest that was aroused as the result of that really was extraordinary. I have had classes in Columbia—the last class was one hundred and eighty men—and there was no difficulty whatever in keeping the attention. You were of course dependent to a large extent upon certain men in the class. You could not get all the men; all the men would not engage in the discussion. But even with as large a class as that you could hold their attention.

As I say, I do not know enough about engineering instruction to know whether these concrete and real things are brought to the attention of the engineering student as they are brought to the attention of the law student under the Case system; but if that can be accomplished in anyway, I think that a great benefit will be derived. And you probably, I should suppose, would have what I think was another result of the Case system in the law, and that is you get them, as you might say legally minded. One of the great difficulties in the teaching of law, and particularly is it true of the legal conception of the layman, and it is that there is a tendency to lay too much stress or emphasis on general principles, on principles of universal application. Now you get a student who studied under the Case system into a very cautious attitude of mind about the acceptance of any general principle which is of universal application. We learn that you have got to study in detail the facts of the particular case before you are in a position to reach an intelligent and wise determination in regard to it. If you can solve the problem that Professor Allen has put, that is, find out what is the thing, that is, what is the concrete thing, you can get before the student, I should think the Case system could be adopted in engineering education with great advantage.

J. J. Flather: Before closing the discussion on Professor Allen's paper I would like to say a word bearing on the Case system in engineering education as exemplified in the teaching of economics. The experiment has now been in force for some three years at the University of Minnesota in which an application of the Case system is in use, and most excellent results have been obtained.

The attitude of the economics department of our colleges has for years past been at war to the more general study of this subject on the part of our engineering students. These departments stated that it was absolutely necessary for the student to take a year's course in the elementary principles of economics before he could go on with the economic problems, which were of vital interest to the engineer.

The work in elementary principles is arduous and irksome and of little interest to the engineering student. In collaboration with the various departments it was finally decided to eliminate the elementary principles and start right in on a year's course on engineering problems in economics, and in order to get the greatest result out of the time spent it was decided to use a certain advanced textbook which related to problems and in connection with that to use as a reference book the text in elementary principles, and still additional to that a Case book of reference. Hamilton's was the book used in connection with this subject, in which abstracts have been collected from various writers, both legal and general.

The method of teaching the subject was by lecture, quiz, discussion, and recitation, and occasionally by bringing in additional men to discuss it; but the reading in connection with the subject was contained in these Case books. Every student had to obtain and use those three books. There was no loss of time going to the library and looking up cases. The student had his own reference book, and it would now be difficult to persuade our juniors from taking that course because they go through it with such enthusiasm.

C. C. Thomas: It has been brought home to me during recent experience in outside work that very likely we are wasting a great deal of the time of the students by lectures instead of by putting them to work on specific cases and having them work problems out for themselves.

I think we can follow the Case method—the specification method if you like—with great advantage to the student. And in that connection I have been impressed with the value of the coöperative system of education. I believe that there is a great deal of value to be obtained by putting young men up against the real thing at as early a time as possible in their course. They will learn very much faster there the matters connected with the actual making of things than they will learn when they are detached from the places where manufacturing is done and are told about these things in the class room.

There is a certain field that I think the university is eminently able to fill, and that is in elaborating fundamental principles that can be taught by experts in a university in a short time greatly to the advantage of the student. But I believe that there are many things which we are trying to teach in the university which could be learned very much more quickly by the student if he were exposed to the coöperative method, as it is called, or at any rate in the shops where the work is done.

I feel that the time in the university is none to long at the present time, but we can take the student further if we limit ourselves in the university to teaching those things which can be properly taught in the class room or by contact with the professor and apart from the field of action in engineering.

ENGINEERING COLLEGES AND ADMINISTRATION.

BY IRA N. HOLLIS,

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It is difficult to write anything new on college administration. A list of papers that have appeared in our journal seems to indicate that the subject is threadbare. Most of our colleges have taken their own way, usually along the lines of least resistance, without much agreement as to methods. A committee of the society was formed either to study administration or to write on the subject, but up to this time little has been done. Perhaps the subject is too complex for any generalization. Education is not like a manufactured article. It cannot be standardized without losing its soul. The success of an institution of learning is so much dependent upon other things than administration that it seems on the whole wise to couple that subject with the whole general question of preparation for the engineering profession.

Education is after all too much a question of the personality and the motive of the teacher to submit itself to well-defined rules, applicable to all cases. What is education? We can easily look up the definition in some dictionary, but is that enough? We must know what we are talking about and agree upon the end to which the education is directed before we can begin to discuss administration. That is my reason for associating the whole general problem of engineering schools with the conduct of their business and with the administration necessary to carry it out.

It is also worth while to define college administration. Heretofore everything outside of the recitation room or of the preparation of lectures has been called administration. One of my amusing experiences was in connection with a very young colored man who told me he was in the administration, when his job was simply helping to copy off marks and to distribute them. As a matter of fact all the business of a university or college is administration. The organization of the faculty and the graduation of the classes year after year all become matters of system especially where the work involves some responsibility and decision. In this paper I am using the word to mean everything outside of actual teaching; everything that interferes with the teacher's giving his entire time to study and to the preparation of lectures; everything that modifies in any way the companionship of a teacher with his students. The business function extends therefore from the trustees, through the faculty and committees, to the handing out of marks and degrees but never crosses the line of the professor's real job, viz., to turn boys into good citizens well able to do the work of the world.

I have referred to the word education and I believe the best conception of it in an engineering school is to treat it as the process of teaching a boy the habit of work and a habit of thought in conformity with the times, or in some cases, in advance of the times. The main thing to be considered about education, however, is that it is not confined to the four years of college life which at best is only an oasis in the years of three score and ten. We all know that an engineer's training does not end with his degree. That forms only the commencement, and yet we rarely live up to our knowledge of this plain truth; for we generally shape the four years of study as if the young graduate were going to enter at once upon his practice as a full-fledged consulting engineer. Our Society has not had the influence upon education that it deserves and that it might have had under a more definite and outspoken program.

Few engineering schools have ever had the courage to take the plunge into a curriculum less closely connected with the commercial needs of the student immediately after graduation, and for that reason the engineering profession is often little esteemed. In the thought of the public it ranges from the blue-print boy in the drafting room to the man who holds the responsibility for building a great waterway, a great battleship or continental railroad. There is evidence among our own members of vague and unsatisfactory classification. The American Society of Civil Engineers is a well-organized association of experienced and capable men in our profession. There is no room in it for young draftsmen. A member must have demonstrated his fitness for directing important work. The American Association of Engineers founded a few years ago in Chicago is essentially a union not unlike the federation of labor for the benefit of its members. I am not trying here to make an argument for or against either of these two engineering societies, as wide apart as the poles in some of their ideals. But, which one of them represents the end to which we as teachers are aiming? Undoubtedly draftsmen are needed and are useful in the work of our profession and some men will always remain draftsmen. With equal certainty great engineers will spring out of the obscurity of small places and small schools; but which type shall our engineering schools prepare to educate? Does the draftsman come from a school of a lower grade than the finished engineer or is the drafting room simply one step between the technical school and the profession of engineering?

About twenty years ago an old gentleman in Boston who had inherited and increased a great fortune, obtained through the work of engineers, expressed the view that engineering colleges should be organized to train routine men; that is, men to fill subordinate positions. While his money had come through the work of engineers he was voicing simply the desire and understanding of many trustees and founders of technical schools in America. They wish to provide the kind of men turned out by the German technical schools of the lower grade. It must be confessed that, while our professors have not this thought, the effect of their teaching and organization has been to carry out the idea of graduating men for a professional trade, and our four-year courses have in many cases amounted to simply advanced vocational training. In a few cases there has been a distinct recognition of higher education but in the main the organization has been planned for the graduation of engineers as young and as speedily as possible.

The articles upon administration appearing in our Journal during the past few years have usually referred to the efficiency of education as appears from the following brief list:

1. "Efficiency in Engineering Education," by Henry S. Munroe. (1910.)
2. "The Application of Scientific Management to the Operating of Colleges," by S. Edgar Whitaker. (1912.)
3. "Operating Engineering Schools under Scientific Management," by H. Wade Hibbard. (1912.)
4. "Scientific Management in College," by Earl F. Palmer. (1912.)
5. "Academic Efficiency," by H. H. Person. (1913.)
6. "The Relation of the Administrative Department to the Teaching," by C. R. Mann. (1914.)
7. "Academic Efficiency, Undefined and Unrewarded," by L. M. Passano. (1914.)
8. "Efficiency in College Administration," by S. B. McCormick. (1915.)
9. "A Plea for the Further Study of Efficient Methods in the Administration of an Engineering College," by C. C. Morris. (1916.)

Efficiency like a medicine must be taken in proper doses administered by a wise doctor if it is to have its high usefulness to an institution of learning. Wherever it takes the soul out of teaching or makes the records and the systems of more account than the actual education of the student, efficiency is worthless. We have an example of that in the organization of an entire nation to do its work and to secure a place under the sun. No nation has paid so much attention to the careful selection of men for the paths that have been marked out for them by a ruling class. The German method was introduced into America years ago and we passed through a period of worship of everything German from the workshop to the university. As a matter of fact their efficiency has betrayed the Germans into a false conception of their mission on this earth and into an entirely unnatural opinion of their relation to the Almighty. We find the professors in Germany throwing the truth to the dogs in order to assist Germany in obtaining dominion over the world. They have appealed to the passion of their countrymen to promote the ambition of themselves as super men. There is no greater curse to a nation or to an institution than the blind worship of efficiency. The word has a high and fine significance when properly applied to the development of men and women.

"There is one glory of the sun and another glory of the moon and another glory of the stars; for one star differeth from another star in glory." Something similar may be said of efficiency. There is one kind of efficiency of the hand, another of the body, another efficiency of the mind or brain and another of human beings when acting in the mass. Yet they are inseparable in their influence upon civilization and happiness just as the glory of the moon is inseparable from the glory of the sun. We as teachers have separated them, but mainly through inability to look upon education in a large enough way. We must define then what we expect to attain before we can lay down even the trace of a road towards proper efficiency. We are in a position like that of a gunner who is firing the long-range shell at an invisible target. Calculations, and study, and allowances must be made and then the gunner cannot be certain that he is going to hit.

The schools of engineering are all trying to produce citizens who through their education and training are efficient in hand, body and mind. Any plan that sacrifices one of these to the other takes away from the value of our system of education. It may be well enough for a manufacturing concern to promote skill with the hand but we cannot limit ourselves in that way. The production of an article of commerce by a system that will either make the most money for a corporation or sell at the lowest price in competition with other corporations has been called efficiency. The development and use of the maximum amount of our natural resources has also been called efficiency. No writer has ever seemed to think of the finest thing that nature produces, men and women, as being the object to which efficiency should be directed. Any reduction in the cost of an article, in the time and effort to produce the article, without taking into consideration the human relation of labor to our whole social life, leads to a one-sided view of efficiency. What is the good of a cheaper article if strikes are promoted? What is the good of anything in our modern industrial system if we are kept eternally on the rack? To-day no one knows what is coming out of the readjustment period following the war, mainly because we have had only a one-sided view of efficiency. Few manufacturers have ever directed their attention to the proper education of their own workmen in ordinary everyday economic truth. I refer to this whole question here not because it is entirely pertinent to the subject under discussion but in the hope that we may not overwork efficiency in our effort to improve the engineering schools.

It would be a mistake to dwell too much on the material side of education. In colleges attention is often called to efficiency in the use of rooms, efficiency in the use of laboratories, efficiency in the hour plan. Seldom is attention called to that organization which serves to make men. Any system is good that will permit the teacher to do his work and to maintain that happy relation found in the term—master and pupil. One has only to go back to the fourth and fifth centuries before Christ to find in Greece exactly that relation under which Athens developed in the leadership in art, literature, the drama, and even in the origin of science. We still go back to that fifth century as the fountain head of everything that we have, and it was done mainly through the schools such as that of Socrates and his pupils, of Plato and his disciples, of Pythagoras and his secret society on mathematics. Furthermore, the best that we have to-day in real teaching is the relation of great masters to their pupils. It may be said that there are few great masters. There would be more if our organization of colleges would only permit the type of teaching and class-room work that form a fruitful soil. I consider Mr. Taylor's work on system in manufacture, called "Scientific Management," perhaps the most important contribution that we have had in industrial science during this generation, because after all our principal development concerns great masses of people. At the same time it is very easy to carry a system too far, especially when applied to a department where it cannot be made to fit. Scientific management in college education is absurd. We all know that there are faults and we all strive to correct them but we also know that in the relation of man to man and student to professor there is no such thing as scientific management.

I should like to make a confession here of views that have gradually become convictions in the twenty-six years that I have been in teaching at Harvard College and the Worcester Polytechnic Institute. What should be the relation of a teacher to administration? I look upon a good teacher as the best that a college can offer. The teachers are of far more importance to a university or college than even the graduate body or the students themselves, because their influence is felt far beyond the academic walls. It is to them that the graduates and students and the public look for the maintenance of our ideals in America, and it is their influence joined with that of the ministry that is the most far-reaching. A man of high character and fine human qualities in the class-room is so far superior to any system of administration that the routine of study is soon forgotten under the influence of such a teacher. There should be as little administration connected with such a man as may be consistent with carrying on the business, to the end that teachers may not be distracted from what is the main purpose of their employment. When a graduate carries into practical every-day life the memory of his association with an unselfish friend under whom he sat in the classroom, he has a lasting and real influence for good.

We have lost a sense of true values in the intense commercial struggle of this century and in America we are too quick to look upon a transfer from teaching to administration as a promotion. It is a great misfortune to a college and to the teacher himself if he is taken from a highly successful relation to students to be put into administration, however well he may develop therein. I well recall in the life of one of my friends the gradual lapse from teaching and investigation into the business of a large university department, and I cannot help but feel that while the university gained a fine efficient man in its business the world lost one of the best investigators and inspiring teachers I have ever known. Who could imagine a man like William James, or Longfellow, or Rankine, or Weisbach, or Rowland, or Aggasiz, expending his thought and effort on details of administration? It may be said that such men are exceptional. They are, and it is our misfortune in the teaching profession that they include no engineers, and that they will become more exceptional in our present commercial attitude towards all education.

It has sometimes been suggested that we do not make a proper statistical study of education and that therefore we lose efficiency. It might very well be asked, who is to make the study? I have in mind the kind of an investigation that was started in one of our great universities many years ago to determine the effectiveness of the university teaching. A questionnaire was sent out by the business office calling for information on all kinds of activities. The thing finally became a joke because some of the best-known teachers in this country were asked for the number of hours in the class room, the number of hours required for direct preparation of subjects to be presented to students, and the number of hours required for indirect preparation. Can any one picture the attitude of mind of Mr. James when he was called upon to tell a clerk the number of hours of indirect preparation for his lectures on philosophy? You cannot measure teaching by statistics. The influence of a fine teacher is something beyond price and the determination of class-room contents, standardization, the number of recitations a week, the cubic feet of air for each student, and other factory equivalents seem ridiculous when measured up against the services of master to pupil. Some reports have been published by the Carnegie Foundation and yet in all these matters relating to efficiency I have been struck by a certain futility. One might as well take up the ideals of a people by counting the number of hours of attendance upon church in the course of a year, the number of square feet per christian attending, and the salary of the preacher per member of the church. As a matter of fact teaching cannot be standardized in its highest sense. It is better to tolerate some waste of money than to permit the morale of the teaching force to decrease and in that way to encourage waste of real brain matter.

Success in teaching is measured by the seriousness of purpose of the teachers themselves. We all know of course that certain sides of administration can be treated very much as the management of a factory. Care of buildings and grounds, the upkeep of apparatus and materials so that they will not deteriorate, and the procurement of materials needed for the laboratories, would classify themselves naturally under some kind of scientific management because the teacher's time ought not to be occupied with administration details any more than is absolutely necessary. Therefore, some kind of a business management ought to be devised to assist them and direct the time of the students. How many college teachers of any quality are there in the United States who will work under a system of scientific management directed by men who have no share in the teaching? There are very few. There ought to be some rules but the chief end is to educate a boy or girl and to make a first-class citizen, not a machine that has been through a shop and perfected by a certain routine method or for a certain definite purpose. Administration may well be directed to one point and that is the payment of professors so that they may have enough to live on with leisure to think about their profession. That is a fundamental question before the American people. If it is answered properly, good men will turn naturally to the teaching profession instead of turning first to commercial positions as giving them a better chance to bring up their families. We have too many cases of poverty among teachers.

The tendency of modern times is towards scientific methods. Everything is reduced to a statistical or tabulated basis and it does not seem to be worth anything unless placed on the ordinary rectilinear curve. It is a good thing in any country to get rid of illiteracy and to train every youth to do something so that his hands may not be idle but any system that shrivels up the soul is essentially bad for humanity and for the individual. Furthermore, any development that lacks the spiritual element renders science a real danger to mankind. We have evidence of that in this war. I have asked the question in another place "Is science safe for human beings?" It has been used for the last four years in destroying property and in shedding the blood of the finest that our nation has produced. Every invention and energy has been put to making science destructive rather than constructive. We have the element of danger always before us by putting into the hands of a few unbalanced extremists power to destroy men, women, children and property. The newspapers are filled with stories of crimes perpetrated by those who have used science without conscience. What gives this whole Bolshevik movement its hold but science combined with ignorance and a lack of conscience? Our ideals in engineering education should take account of this fact and the system should be primarily a training in conscience and the will to do right first, and then a technical education.

It is well worth while to review briefly the types of organization to be found in education. Reference has already been made to the most flourishing period of Greek history when the Greeks rapidly came to the front in everything that lies at the basis of human life and happiness. The only thing they did not have was the example of Jesus Christ but Christ patterned his methods on that of the Greek schools. A man like Socrates would set up what practically amounted to a course of lectures in the market place or elsewhere and his disciples would follow. Education has never flourished as it did under those men. There was no thought of efficiency or system or organization—it was master and pupil or master and disciple. This type of school has extended down to our own times. It is what is meant by the saying that Mark Hopkins on one end of a log and a student on the other constitute a university. That seemed to be Mr. Agassiz' theory when he went in 1847 as a professor to Harvard College. He practiced exactly that type of teaching—master and disciple—and under him natural science immediately became popular in the United States. His pupils have been marked men especially those who studied under him in the little old wooden museum at Cambridge. Every one of them achieved distinction. There is an example of this in the German universities where the professor gives his lectures to those who choose to enter his courses. In a university, where there are many professors and many students some system has to be adopted so that the lectures are not all given at the same hour. Organization and administration, however, are never concerned with the class-room work. That is entirely a function of the professor. Even in the technical schools of Germany something of this idea prevails. I well recall some lectures that I attended in Charlottenburg when I was making a study of the German technical school system. One lecture on the compound engine was given by a professor who invited me to go into the class room with him. He was polite and there he introduced me to the two hundred and fifty students sitting in front of him. The lecture lasted one hour and a half. There was no textbook, no record of attendance, no conversation with the students. The lecturer simply went into the room, gave his lecture, and then walked out, the students being left to do the best they could to study up on the subject through text-books that they found in the library or elsewhere. I do not recall even any conferences with the professors and I did not see such a thing as a recitation. The main evidence of administration at Charlottenburg was the annual report written by the rector.

A modification of the German system was found at Harvard University under the unlimited elective system where a student could take practically what he wished and graduate after four years of study, having completed seventeen and a half courses. This system has been modified so that all students are required to concentrate on a major subject and to skate around many minor subjects, but at Harvard the attendance was taken and there was some requirement as to annual examinations. The proposed new system at Harvard is to have examinations at the end of the four years of study on all the major subjects that students have taken. This means of course that no student can get through without a good general knowledge of at least one subject. Of one thing a visitor at Cambridge might be certain—he would find the class rooms of professors crowded if the lectures were presented by a man of real gift.

The most organized type of higher education is found in the prescribed systems of small colleges. They used to be classical and some still are classical but we have added all kinds of up-to-date subjects in most cases with a little election during the junior and senior years. Engineering schools, however, have as a rule a rigidly prescribed course of study beginning where the high schools leave off and continuing through four years gradually becoming more and more professional. Usually the first year is the same for all branches of engineering and the last year is exclusively technical.

The net result of this preliminary consideration brings us to the question, What is the place of an engineering school and what should it acomplish? This has a very direct bearing upon its administration. Another question might be added, Must there be only one type of engineering school? It seems to me foolish to lay any stress on the method or type as being the final word. No engineering education can be standardized without running the risk of losing much that is valuable in the individuality of different teachers. As a matter of fact most men make themselves and a course of study has little to do with the magnitude of their careers. Often it has nothing whatever to do with their occupation in life. Any school will prove this fact and make plain that a man's chief education comes with experience in life and from study after graduation, sometimes retarded by a course of study which has to be unlearned. The man's education, however, must be his own if he is to achieve any distinction whatever.

I take as an illustration of a rigidly prescribed course. the United States Naval Academy, because I am familiar with it and because it is one of the best examples of a curriculum that has no elasticity. In the first place it is strictly utilitarian in the sense that no attention is paid to anything that does not count towards the training of a naval officer for sea duty and for a limited number of international problems that may arise between our country and foreign nations. Everything that does not find a use is excluded. There is no great attempt at real teaching. It is a "sink-or-swim" method. The lessons are given out and the midshipman must learn them for himself or fail. It is really a case of intensified training and discipline and then of careful weeding. Our courses in engineering schools must necessarily be on a broader basis because we never know beforehand just what branch of the profession our graduates are going into. That often is a question of opportunity and the industrial condition of the country. Nevertheless the great majority of engineering schools are like the Naval Academy minus the discipline. The Navy always knows what its graduates are going to do and the energies and organization can therefore be directed to that one thing—to make men for the best fighting machine in the world and to fulfill its purpose and function better than any school in the United States or perhaps in the world. Theodore Roosevelt once told me that he considered the Naval Academy the finest school in the world, meaning by that that it carried out its function better than any place else in doing what it set out to do. And what is the result? It produces good officers who have shown in this late war their capacity to work efficiently and enthusiastically. But it goes further in that it graduates a large percentage of men who leave the Navy and go into other professions entirely outside of the course of study. They obtain their education for their work on top of the Naval Academy training which is valuable only through its discipline. It is easy to show what graduates of the Naval Academy have been capable of doing by simply naming a few of them: In history, Alfred T. Mahan, who opened up a new field for historians. In literature, Winston Churchill, Cyrus Townsend Brady, whose novels most of us have read. In invention, Frank J. Sprague, the father of the trolley system. In education, Mortimer E. Cooley, who built up the first great engineering department in a university. In business, Homer L. Ferguson, lately elected president of the U. S. Chamber of Commerce.

It is not intended here to give any list of the graduates of the Naval Academy who have distinguished themselves outside of the Navy and the purpose of this reference is only to show that men who have acquired the power of application and the initiative to do something with themselves are not dependent in any way upon the curriculum of any school, its organization, or its administration. They find their chief stimulus either within themselves or from teachers like Louis Agassiz. We get back then to the question asked before—What is the purpose of an engineering school? It is to train a large number of men for the ordinary business of engineering, leaving to the exceptional who are capable of striking out into new fields the education of themselves. An engineering school may well have a semi-military character as the student is to graduate into a profession requiring system and accuracy but it does not follow that he must be turned into a machine by methods reduced to a standard.

We have certain illusions in our schools. One of these is that a teacher of engineering is a great asset if he continues his activities in the practice of his profession. As a matter of fact he is often a brake upon the development of first-rate teaching. If he is a good teacher, the time spent in outside business is a distinct loss to the institution with which he is connected. There is a lot of loose talk about keeping up with the advance of science and its newest applications. We in engineering education know that the fundamentals are more important than anything else, and that the best method of keeping up with the times is to learn the best method of presenting fundamentals, not of keeping an array of facts before our students, even though these facts spring from the latest investigations. A man cannot ride two horses except in the circus ring. The work of an engineering school is far more fundamental than the latest advances which in their turn in a very few years, often before the young graduate has really gotten into his profession, become the antiquated practice of a rapidly receding past. We are in the profession of teaching and time spent in studying the methods of presenting a subject to students is far more valuable than the same time put into practical application. America has been a partial failure in its engineering schools because it has developed very few writers of first quality. Our books are usually slipshod, prepared at odd hours between the preparation of lectures and the practice of consulting engineering, simply because our teachers have been encouraged to supplement their insufficient salaries by outside work. We are thus in the habit of flattering ourselves with the thought that we are keeping up with the times. The only really practical advantage in a teacher's connection with outside work is that he stimulates the imagination of his students and in that way obtains from them a larger measure of effort and interest.

Another illusion that is common to colleges is that the subjects taught in an engineering school must necessarily be less broadening than the subjects in non-professional colleges. That is not true of the engineering school that devotes itself mainly to fundamentals. There is not a subject fit to be taught in a technical school that cannot be broadened and enlarged to make it a real education. In 1893 the engineering courses at Harvard College were completely revised and every one of them, except the workshop courses which were almost exclusively hand work, were accepted as part of a liberal education for the A.B. degree. This was freely granted by the teachers of classics and others on the Harvard staff. Unfortunately all teaching for the profession of engineering was given up when the agreement was made with the Massachusetts Institute of Technology.

The administration of a college differs ordinarily from that of a business corporation in that it must be more democratic and must take more account of the wishes of those who are employed in its service, and the teaching force must be consulted and controlled only so far as to hold the institution together. A good teacher can always do his best work when free to direct his energy in the manner he considers most advantageous to his students and in a way that will develop his own thought as well. His profession confers upon him responsibilities and privileges on economic, social and scientific questions sometimes difficult to reconcile with the views of boards of trustees; hence the discussion of the words "academic freedom." On the whole it is better that a teacher should be free to discuss any subject so long as he does not disgrace himself or degrade the institution, and this applies to engineering schools as well as to the larger universities. When we contrast the behavior of our professors under a system that does not put restrictions upon them or require any special doctrine to be taught with the behavior of the German professors and their betrayal of both profession and country in the support of military Prussia we must find a real reason for congratulating ourselves upon the freedom of thought in the universities, colleges and technical schools of our country. Fortunately we have no privately endowed institutions that have any tendency to inflict upon their teachers a particular political partisanship or any phase of academic doctrine.

College administration must take account of the fact that the highest aim in any school is enlightened citizenship in this republic, in addition to the specialties for which the school is founded. In this regard we sometimes are tempted to separate the technical school from the ordinary college but the purposes are not essentially different and we may better emphasize the likeness rather than the differences. An engineering school is intended to supply a young man with at least the introduction to a profession as well as his general education, while the college attempts merely a general education as a basis for subsequent professional study. Attention has already been called to the fact that most of the subjects in an engineering school if properly taught are capable of being broadened out into a general education. It is entirely a matter of emphasis and the personality of the teacher. We hear much of the broadening of a great university and yet the broadening springs largely from the fact that the university has money enough to employ teachers to whom a large amount of leisure for thought and study is given. A good man has a broadening influence without much regard for the subject that is taught. Greater consideration ought to be given to the type of man who is teaching. A really inspiring teacher could make of a course on steam pumps something vastly more effective even in the teaching of English than a young assistant of no experience in life could make out of the teaching of English itself. Let us remember this in connection with administration of colleges and in the selection of teachers.

A study of administration may be taken up on a considerable scale by assembling and classifying all college catalogues, but I find this method comparatively fruitless. It is better to make an examination of comparatively few typical cases remembering that the personality of the men in the administration has far greater influence upon the results than the exact organization itself. Consequently I am concerned here mostly with the kind of administration under which teachers have the greatest amount of freedom and under which the student finds the greatest stimulus to study.

All the activities of an engineering school may be divided among comparatively few heads.

1. *The Financing of the Institution.*—This is a matter largely for the trustees and for the friends of the school, and it should not be a part of the work of the teaching staff. No fixed rule can be made inasmuch as privately endowed colleges must get help where they can through teachers or anybody who is effective. There is one matter to which the most scrupulous attention should be paid; viz., that the income from funds should be used so far as it is possible exactly for the purpose named in the deed of gift or in the bequest. If there is one place on this earth where the truth should prevail and where a benefactor should obtain exactly what he requests, it is a college. Truth and honor should be maintained at the expense of refusing some gifts.

2. *The Plant and its Maintenance.*—This is a business matter similar to that of any commercial establishment. The principles of scientific management may very well be applied in the care of buildings, laboratories and all property of an institution of learning without in any way interfering with the relation between professor and student. The business side of a college should not be put upon the members of the teaching staff if it can be avoided; at the same time a superintendent or agent should hold his position only by his acceptability to teachers, his understanding and sympathy for their work.

3. The use of rooms and laboratories, the hour plan of recitations, the penalties and rules, and the physical training, all of which constitute faculty business, to go before the trustees only where they involve money or question. So far as possible the faculty business should be committed to standard committees on discipline, on records and on the enforcement

of rules. It has been customary in the past to carry cases of discipline to the faculty but it is of doubtful wisdom except for the information of all teachers; even dropping a student for being unsatisfactory in his studies can be made a function of some committee.

4. *The Teaching in the Class Room.*—This is always by means of lectures, demonstrations, recitations or conferences and will form the purpose for which a school is established. This must never be lost sight of. All organization leads to this end and to nothing else.

5. *Relations with Students Outside of the Class Room.*—This is so much a matter of informal daily contact between professor and student that no rules can be laid down. It will always be dependent upon the temperament and sympathetic understanding on the part of the teacher and it is possible that this beautiful relation may be the best thing that a student gets out of his college life. The fine service that goes to build up a boy's character is more an asset for citizenship.

6. *Student Activities.*—A college that does not encourage in some way student activities outside of the class room becomes too rigid and it does not produce a type of graduate who can adapt himself to the conditions of everyday life. Some religious schools are of this kind and many engineering schools over-crowd students so much that they have no time for what might be called a course in human relations and friendship.

I have no intention of dwelling on these matters. They have to do with administration only so far as the background is naturally made by the governing boards. The first three of them relate entirely to the business of an institution and the last three to the education of young men. The whole purpose of this paper would be misunderstood if it is interpreted to mean that I do not believe in efficiency and good business administration. I do most heartily believe in both and in a proper organization but never at the sacrifice of that human relation which does more to turn a boy into a good man than all the organization in the world. I have dwelt on the word efficiency because we have made a fetish of it. Of course we all know that an engineering school is primarily an institution for teaching engineering and for giving a young man his start in the profession. Consequently the primary purpose relates to science and the things that a student must learn form part of the profession. That is first and organization should have that in view, but again I repeat, never at the expense of the soul.

Every college has its board of trustees, sometimes called a corporation, a board of regents, or simply a governing board. It makes no difference under what name this board appears it must necessarily take responsibility for the institution. There are two types of organization of trustees; one is a single board like a business corporation, and the other is a dual board like a business corporation with a senate that must pass upon its acts. In some cases these boards are elected or appointed and serve for a term of years. In most cases, however, the members hold a life tenure and the board is self-perpetuating. No two colleges are managed in exactly the same way and there are many types of boards. In order to bring before the Society a complete exposition of this matter it would be necessary to exhibit the framework of every university and college in the United States. They may be divided as above into two types, a few examples of which will be sufficient. The old style college still exists in places like Bowdoin, Amherst and Williams, and they fill a very useful place in our system of education. They have their board of trustees made up in part of ministers and in part of business or professional men elected with a life tenure. We are not concerned with these so much as we are with those that have engineering departments or are solely planned for engineering education.

Yale University has a corporation consisting of the president and fellows, in number nineteen, elected either for life or for a term of years. The Sheffield Scientific School has also a board of trustees of nine members. This board is a corporation, three of whose members are ex-officio, viz., the governor of the state, the president of Yale College, and the chairman of the Peabody Museum trustees. The other six hold a life tenure and fill their own vacancies. The director of the Sheffield Scientific School is the secretary of the board. It will be observed that the graduates of the Sheffield Scientific School have no voice in the government excepting so far as they may be chosen by the surviving members to fill vacancies. The organization at Yale will probably be affected by the general discussion now going on.

The Case School is apparently incorporated and is held by a corporation of twenty-two members. The business of the institution is directed by a board of trustees consisting of seven members chosen by the incorporators. The graduates would have no voice excepting as they are chosen to be trustees, and the president is not a member of the board of trustees either by election or ex-officio.

Rensselaer has a board of trustees consisting of twenty-three members holding a life tenure and the mayor of Troy as additional ex-officio. The president of the institution is also president of the board of trustees and the graduates apparently have no voice in the choice of the members. This case is much like the old-time board of trustees for colleges.

The Massachusetts Institute of Technology has a corporation consisting of fifty-three members. the president, the treasurer, the secretary, the governer, the chief justice, and the commissioner of education, all of Massachusetts, being ex-officio members. There are thirty-two life members and fifteen term members, three being elected each year for a term of five years. There is besides an executive committee consisting of the president and treasurer and five members who are chosen by the corporation from among its members for a term of five years. This committee has power in all appointments and fixes the salaries and duties of all officers. It has entire responsibility for all the property of the institute. The fifteen term members of the corporation are elected by the corporation from a group of candidates submitted by the alumni of the institute. The corporation as a whole confirms appointments, confers degrees and authorizes certain financial transactions.

Harvard.—The government of Harvard is by two completely independent boards. The first board is known as the corporation, consisting of the president and treasurer and five fellows, called usually the president and fellows. The members have a life tenure and vacancies are filled by the surviving members. This corporation transacts all business, makes all appointments, and in general may be regarded as the directors of the institution. A second board, called the overseers, consists of thirty members. Five of these are elected every year for a term of six years, at the end of which time they are eligible for one more term of office. The board of overseers approves all appointments without limitation as to the time and in general takes up questions of policy submitted by the corporation. The president of Harvard is chairman of the corporation but is not a member of the board of overseers.

Michigan University.—This university is a fair type of the larger state universities although no two of them have exactly the same plan of government. Michigan has a board of regents consisting of twelve members. Of these the president, the treasurer and the secretary, and the superintendent of public instruction, are ex-officio members of the board without vote. The other eight members are elected for a term of years by the people of the state and apparently form a committee to direct all the educational and business affairs of the university.

Other universities and colleges have all kinds of modifications of these six plans. The general tendency is towards a greater participation of graduates in the affairs of their alma mater and ultimately the colleges will probably be governed by the alumni asociations. Furthermore, the dual organization is probably better adapted to private schools than it would be to state universities whose boards have a limited tenure of office. A permanent board is likely to become more or less inactive in course of time, especially if there be associated with it one or two men who carry the financial burden on their shoulders. It is not a sign of prosperity for a school to possess some interested individual who is ready to step forward to pay all deficits. As has already been stated, the character, interest and personality of the men on the board of trustees is of far greater importance than the exact type of organization and the same thing holds with regard to a faculty. Every one of the different schools may have its own individuality without necessarily having inferior methods. The important thing is the man who is sitting in the class-room chair, it is his influence that will tell upon students in the long run. The relation between the board of trustees and the faculty is important. Often the trustees, who are business men, cannot be brought to take a real, intelligent interest in the work of the class room. Occasionally they take too much interest and meddle with the teachers. There has been for years a discussion about giving the faculty a share in the government of an institution and sometimes teachers have felt that the president of a college has altogether too much power. Some reports have been drawn up on this subject. It would seem to me unfortunate to have the members of the faculty pass upon a number of questions that now belong peculiarly to the trustees. I do not think that any professor can possibly be in a comfortable position when he is passing upon the salaries of his own colleagues. This is true even in the departmental government of a college where the head of a department assumes to decide the salary and work of a teacher associated with him.

It would be useful to have occasional meetings of trustees and teachers on certain larger questions of policy like entrance conditions, the courses of study as they ought to be given and the enlargement of the curricula, but when it comes to the actual share in the executive management of an institution the teacher is in a totally false position. His time would be taken away from the essentials of his profession and put into chores. The grievances expressed by some faculties are largely in the nature of appointments and dismissals. It is perfectly obvious that a man who is appointed a professor should be acceptable to his colleagues unless some reorganization or reform is absolutely needed to better a bad situation. Consequently, the appointments in any department ought to come by recommendation or consent of the appointee's future colleagues. If such recommendation comes only from the head of a department, it might as well come from the president of the college. In the matter of dismissals a professor who has taught for many years ought not to be lightly dismissed and the whole subject ought to have full investigation by the trustees. I have heard many business men say that teachers were employees in the same sense as men in the industries. They are often treated in exactly that way but I think it is a great mistake. The profession of teaching is like the ministry a privileged profession and a man who has taught twenty years is in the same position as a preacher in regard to the outside business so that if he is dismissed he is comparatively helpless. I have known a few preachers who have turned to soliciting life insurance as a means of getting a living and there is no more melancholy sight in the world than an old teacher who has no support. As a rule the pay is not enough to enable teachers to lay by any money for their old age, hence they cannot be treated as to appointments or dismissals in the same way as a man in a business position. The value of a teacher's work is very rarely measured by his pay as will readily be disclosed by the great variation in professors' salaries. They vary from $1,500 per year up to $7,000 or $8,000 depending upon the institution, and yet a professor in a small college probably does as good work with his students as those in larger ones.

The Carnegie Foundation has provided a method of taking care of the most serious cases of breakdown in the college service and of getting rid of those whose usefulness has passed by reason of illness, or old age. In future the Foundation will not have so great a power in the matter as it is changing to a type of insurance company.

One often hears the statement that professors are not business men, as if that were a reproach. We may be thankful that they are not. Let us have in America some place and some profession that is not commercial so that we may at least preserve the finer ideals of our forefathers. If a teacher is a good business man he would better go into business and let teaching alone. If he is a good teacher and is capable of stimulating a higher type of character in the student, he ought to give up all thoughts outside the class room. If he is neither he might better be on a farm.

What is the place of a president of an institution of learning? Few of the foreign schools have any such organization as we find in the United States. In England and Germany there is no such thing as the president of a university or college in our sense of the word. The head of the Charlottenburg school is a rector appointed by the government for one year. All appointments to professorships are suggested by the faculty, usually three names are handed in to the government and from these one is selected by the minister of instruction. If none of the three names are satisfactory to the government, three others are submitted until a man is obtained that the minister of instruction will accept. While this apparently is a democratic and open method of appointing professors it really does not differ from the American method of going after the man that is wanted. The president of a college in the United States holds a position very largely as business manager in addition to being at the head of the educational side of the university or college. But his position is often distinctly inferior to that of a teacher who has leisure to study and write. The position is not, however, that of an autocrat as the holder must remain acceptable to the trustees, must find money to run the institution and must be able to convince teachers. On the whole it would be better if the president of every college were the disciplinary officer and had the care of scholarship and loan funds. Whether a changing head such as that in Germany would be good or not in the United States has never been thoroughly tested. The University of Virginia gave up an old system to have a regular president.

Probably the present practice of electing a president into whose hands is placed the business and educational matters of the institution is well adapted to the American mind and cannot readily be changed. One of the difficulties with the position, however, is that often too much business is put on the shoulders of the president who has no time for educational matters. This fact has led in many colleges to the appointment of a business agent or a publicity manager to serve with the president in certain business matters outside of the teaching field. Only the larger universities have money enough to separate business from teaching. The tendency of business agents who do no teaching, however, is unfortunately towards commercial methods. Especially is this true of publicity men.

The method of bringing colleges to the attention of the public and bidding for students is very much the same as we find associated with the sales department of any manufacturing company. In some parts of the country the college drummer is sent out to get trade and all kinds of publicity propaganda are devised to lead students to attend the colleges advertised. I believe this to be altogether bad. It may be said that more young men are thereby induced to educate themselves but I do not believe that to be true. A large number are misled into thinking that they ought to get a college degree than are helped by the advertising method. Should engineering schools advertise at all? It is doubtful. Their publicity ought not to extend further than a good description within the catalogue of what the college offers. We ought not to acquire the competitive spirit so much that we shout with joy if we can only show a few more students than our neighbor who is also teaching engineering. The newspapers are filled with stuff of that kind from the larger universities. It usually emanates from publicity agents who are employed to keep the institution before the public which is often deceived as to what the colleges are really capable of offering young men. One of our colleges has a publicity agent who is going out to get 400 more students. The pamphlet by which these students are to be obtained has the same misleading quality found in advertising departments of business houses and represent to my mind the last state of degradation in education. There would be a distinct gain if all engineering schools and engineering departments would join to offer within the same binding a brief description of their names, purposes and work. This could be sent out all over the country and would serve the purpose of indicating the opportunities for education in our profession.

How should a faculty be organized? Undoubtedly the best method of doing business is under some kind of departmental government. An engineering school has naturally certain important departments like civil, mechanical, electrical and mining engineering, chemistry and perhaps architecture, each one with its staff consisting of a chairman, or head of a department, and the colleagues who join in carrying on the work of the department. It is bad, however, for any college to have too strong a departmental organization or to have one department overtopping its neighbors. Rarely can the most effective coöperation be carried out under such a system. It has always seemed to me better to have a head of a department chairman for a term of years and to have the office changing occasionally so that the chairman of the department becomes largely the mouthpiece of the professors and not the director of their work and their energy. In many colleges, departments constitute what an officer in the War Department has named a parallel organization with every bureau having full authority and no person or persons having wide professional knowledge to reconcile differences. A certain amount of emulation and competition is useful but pigheaded obstinacy or jealousy in the maintenance of one department against another is destructive of efficiency and business in a college as in the government departments.

The faculty is necessarily divided into committees for the admission of students and for supervising their work. It is almost imperative that every faculty should have as one of its committees an administrative board, whatever that board may be called, to see that the students keep to their tasks and, if they do not, let them know about it. This is really a friendship board as well as a disciplinary board because through it the students are assisted and their delinquencies are called to the attention of the faculty. A third committee is useful in any faculty—that relating to the organization of courses and the schedules leading to a degree. These three committees necessarily form the backbone of any organization, other committees being largely subordinate and effective only for short periods. It has sometimes been said that the president of an institution ought to be a member of every committee but that seems to me unnecessary. He ought to be a member of only the committees on which he can be useful. Sometimes it is a positive disadvantage to have him a member of a committee because the member in that way lacks freedom to make up their own minds in their own way.

The arrangement of hours for lectures, recitations and laboratories commonly called the hour plan for students often presents great difficulties. It becomes almost impossible in a large university when the engineering instruction has to fit in to a long-established plan for academic study. Exactly that happened at Harvard when engineering was reëstablished in 1893. For that and other reasons the engineering department of a university must be separate from the academic department. In most cases even the language and mathematics must be given separately, thus establishing a school by itself in an alliance with the academic department, the law department and the medical department. Its methods and its purposes become thus almost the same as those of the ordinary technical school. As a rule the hour plans are too unsystematic and often demand very irregular hours on the part of the student and of the instructor. It would be worth while to make a better study of this for technical schools generally. The Naval Academy had for many years a plan of two hours assigned to each subject. This meant 8–10, 10–12, 2–4, every day. Classes were arranged in small sections having recitations one hour and then one hour for study in each of these periods. The ordinary civilian college might have something of the same arrangement. At the Worcester Polytechnic Institute the hour plan is an annual affair because it depends to some extent upon the number of students and the consequent number of divisions in each class. This becomes a serious task to some of the instructors and adds to their burdens entirely outside of teaching.

Engineering schools are constantly receiving suggestions about improvements in their courses of study. I have just now on my desk at home either outlines or suggestions for new courses covering safety engineering, administrative engineering, business engineering, human engineering. aeronautical engineering, mental hygiene, and I do not know what to do with them. These propositions are symptomatic of the whole country where everybody has a happy thought which he is exploiting. Washington is infested with the happy thought people who are working out new plans. Our trouble is chiefly that we are not unlike the Bandarlog of Kipling's stories. We cannot in the ordinary engineering school add any new courses for we have not the space for them. We might substitute other courses in order to change the engineering program into one for business men. It seems obvious, however, that our first task is the education of young men in the fundamentals of applied science. While education ought to keep up with the times it would be a mistake to substitute for the ground work on which our profession rest, something that is merely technical and informational. No subject that has been found by long experience to be of value in developing the mind ought to be abandoned for a technical course in administration, business or aëronautics. Engineering education will gain nothing if we are led astray by the results of the war into professional courses which a man would naturally learn after graduation. Some universities and colleges have adopted in their engineering departments a straight three-year course in engineering with no specializing whatever, leaving the fourth and perhaps a fifth year for a large amount of professional work. If this can be done in such a way as to place the last years at the disposition of the department in which a young man is going to graduate the hour plan is simplified and the whole course of study is made systematic. It may be added here that a fifth year, especially if spent in another college or university would be excellent.

It has been suggested that the engineering schools ought to have a closer alliance with the engineering societies. I have written a report on that subject for the information of the American Society of Mechanical Engineers in the hope that that society may take some share in the education of students for their profession. There are now about forty-eight student branches of the society in the United States. It is possible that our own society, the S. P. E. E., might help this relation by interesting itself in the student branches of all societies. Two points have been suggested. First, that certain scholarships should be offered to the engineering colleges having student branches, and second, that a definite program of work to be conducted by the students themselves might be planned out in a syllabus of some kind. At the present time most student branches or student societies break down because they do not have anything that really appeals to them for their weekly or monthly meetings. There is no use in a student society's attempting to repeat for the edification of its members what is given in the classroom. My belief is that some interesting subjects disconnected from the studies might be worked into a little handbook that would prove extremely valuable. I have ventured to suggest any one of the following for the coming year:

1. The general effect of the peace conference and the league of nations upon the work of the engineer, especially in commercial life of the nation during the next generation.

2. The method by which war disorganizes industries and the work of reconstruction that invariably follows every war.

The general readjustment that must follow this war in all the belligerent countries.

3. Standardization for manufacture and the effect of this war in forcing engineers and manufacturers to reduce the number of parts and to simplify construction of all kinds of machines. Standardization for guns and munitions.

4. Conservation of national resources including fuel, water, soil, forest and minerals.

5. Labor and the complete readjustment of society in order that employer and employee may live together in peace. Examples of the solution of problems in different manufacturing companies.

6. The problems of transportation, national and private ownership, and the changes consequent upon improvements and rapidity of transportation.

A student branch may have a number of purposes so that the above is offered merely as a suggestion. I am listing here as a further suggestion the general purposes of student meetings.

1. To get outside lecturers on technical subjects.
2. To get outside lecturers on non-technical subjects.
3. To get salesmen or agents from manufacturers to describe their product, usually illustrating with a stereopticon.
4. To obtain lectures on general subjects from members of the general faculty with which the engineering department is connected.
5. To encourage students to speak on their feet in public meetings (*a*) by giving them the periodicals and books to be reviewed orally; (*b*) by having the results of these and investigations conducted by the student described; (*c*) by the delivery of brief addresses on non-technical subjects.
6. To broaden the contact with engineering by joint meetings with other branches of engineering in the student engineering society.
7. To bring students together, mainly for social purposes and for making them acquainted with associations and their usefulness to them personally.

8. To teach them initiative by non-interference with the student branches, thus leaving to students all activities outside of the classroom.

Just at this time we have a great deal of discussion in the United States on the subject of research. How far ought research to be encouraged in a technical school and in a university? The two types of institutions differ in this regard because the technical school rarely has the money to conduct research on a sufficient scale to make it of great value. Some of the professors and instructors have time to do something and it is to be hoped that legitimate and proper research may be encouraged. We all know, however, the sham that often is perpetrated in the name of research. Theses are usually worthless so far as the engineering world or applied science is concerned. Furthermore, we are in a fair way to go at research in much the same way as a housekeeper would go at sweeping up a room to find a pin that had been dropped. We cannot sweep up the whole universe and our science as it is to-day will be something different to-morrow. There is room for a much better organization for study and research by bringing colleges into relation with the National Academy or with the testing departments of the great industrial firms of the country. Let us never forget in this connection the danger which science may hold for the whole human race unless we approach it in a spirit of righteousness, with a determination that it shall never be used for the destruction of all that mankind has done up to this time.

Has experience in the Students' Army Training Corps taught us anything? We must remember the two types of colleges. Those that have nothing but what is known as a general education as the end in view and those that have training for some occupation in life. The effect of the experiment with the Army varied much with different colleges all over the country. In New England it was not very satisfactory with any kind of a college. In the Middle West it seems to have been acceptable. I do not share the views of many educators, because I do not believe that we learned anything of any great value to us about courses or administration during these few weeks of military control. The war conditions taught us a great deal but it was not because we were closely allied with the Army. It is possible that colleges with no professional aim were benefited in some way. Instruction, however, suffered as the course of study were seriously interfered with and the object for which studies were given were largely lost sight of. We had a case in Worcester where young men were sent away to the heavy artillery school from two colleges, those sent from the Worcester Polytechnic Institute having had a first-rate training in mechanical engineering and those sent from an academic college largely religious in character having had no training in engineering. This was absurd. The net result was on the whole a lesson against too much control by the Army and Navy.

If military training is to be continued it should be on terms offered by the engineering colleges and arranged in such a way as not to interfere with either administration or organization. If the specifications are supplied by the War Department in which the colleges have no voice there is certain to be the same kind of a result as that with the Students' Army Training Corps. The officers of the Army do not as a rule know much about education. Many of them have graduated from West Point which is a school of discipline—not an educational establishment—and consequently they usually err in making their plans too rigid. The summer vacation is the time for military training and under proper conditions six weeks every summer at a Plattsburg camp might be made one of the requirements for a degree. During the school year students should be under their regular faculty without any military control whatever and during the summer they could be under the discipline of the Army or Navy without any faculty control. Some additions or substitutions in the nature of physical training, military law, and the military policy of the United States might be advisable but it is doubtful if any technical training in materials for war would be worth while. Engineering schools are not unlike the professional schools of law and medicine where it would be poor business to place a military unit. Consequently any arrangement with the government ought to take into consideration the specialties for which technical schools train their students, specialties that are of the highest value in time of peace and of supreme value in time of war for manufacturing weapons and putting them into the hands of the soldiers.

I have made no attempt to go into great detail in this paper because I believe personality and character are far greater elements in the success of an engineering school than any type of administration. Our conception of man's life as one of orderly and steady development through the various schools so that a child may enter the primary department, subsequently the college, and lastly the career, without confusion, is not sound. Every one of these changes marks a sudden break and a necessary readjustment to new conditions. There is no system of instruction and no system of administration that will enable a student to glide smoothly from the secondary schools into the freshman year of college. He must get a jolt of some kind and must find himself under conditions approaching manhood where he is freed more or less from the tutelage of the home, of the boarding school or a high school. It is not necessarily a bad thing for a boy to have a break of this kind and it is rather a good thing that different colleges and preparatory schools should have their individuality. When we standardize education in such a way that all schools are alike and all teachers are alike, it will be nearly time to go back to the forest to live on nuts and berries. The chief interest in life is found in variation and no school ought to forget that.

We all know that organization depends for its effectiveness on men and women far more than on rules and constitutions. Yet some rules promote trouble and the chief effort towards college administration should be towards some system that minimizes the possibility of friction or lost motion and at the same time encourages the individual to exert his best effort. That is the only reason for administration of any kind. My conclusion is, that while the work of a college outside of the class room is interesting and while it should be well planned and carried out, the essential task is the education of boys and girls and the development of good, useful citizens capable of doing something. We have had too many examples of what administration and its unintelligent methods can do for a department in our own government. At times it seems almost impossible to do business either during peace or war. Certainly we have much to regret over the cast-iron system based on what is known as "passing the buck" and keeping minute records of things that have no importance. It was the most unsatisfactory performance of the war and but for the manhood and courage of our young soldiers overseas the scientific management in Washington would have lost the war. It is known as red tape and every government in the world is afflicted with it.

I can see only certain essential things of a definite nature to recommend in relation to the maintenance of a college, taking for granted that as much administration is put in as will carry the work without friction. They are:

1. The time of a teacher should be occupied with administration as little as possible.

2. The class-room work of a teacher should afford him leisure for improvement in presenting his subjects to students.

3. Students should be encouraged to present and discuss subjects for themselves, usually outside of the class room.

4. The national engineering societies should be asked to coöperate not only with this association but with the colleges themselves towards broadening out engineering education.

5. The salaries of professors and instructors should be sufficient.

RESOLUTION ON BUSINESS TRAINING FOR ENGINEERING.

"In view of the fact that the Society for the Promotion of Engineering Education has coöperated in the promotion of this conference and in the effort to secure the results outlined in the resolutions, would it not be becoming as a matter of record for your Society meeting at this time to receive this resolution and have it read at one of the sessions?"

It seemed to me that was very appropriate, and, therefore, I will read the resolution, which was unanimously adopted at the end of that conference.

"*Resolution:* It is the sense of the meeting that: First, industrial and commercial development has created a demand for men with technical engineering training and business ability. Manufacturing industries are seeking engineers to qualify to serve in capacities requiring sound business training. Bankers and brokers also need men with business training and the engineering point of view. This need is rapidly increasing and bids fair to demand a large number of technically trained men for both domestic and foreign commerce.

"Second, in order to meet this demand the economic basis of engineering subjects should be emphasized wherever possible in engineering instruction. This may be done by emphasizing the problems of value and cost in the regular technical work or introducing or extending courses in general economics, cost accounting, business organization and business law into the engineering curricula. These courses should be designed particularly to meet the needs of engineering students.

"Third, the engineering phases of economic subjects should be emphasized wherever possible in commercial instruction, and students in commercial courses should be allowed to take courses in the basic principles and practices of engineering so they may understand in general terms the operation of power plants and transportation systems from an engineering point of view.

''Fourth, it is also urged upon all institutions with departments in engineering and economics or commerce that they consider some plan of coördination to develop a course in preparation for those careers wherein practical training in modern languages, in the science of engineering and business theory and practice have been found to be both helpful and necessary.

REPORT OF THE SPECIAL COMMITTEE ON REPORT OF JOINT COMMITTEE ON ENGINEERING EDUCATION.

Mr. President, and Members of the Society: It is with some hesitation that I present these resolutions as a committee report. Those of you who have discussed the Mann report in your faculties and with engineering teachers, will realize how divergent are the points of view. The members of the Committee appointed to discuss Dr. Mann's Report were also geographically very far apart, one in Texas, one in California, one in Cleveland, one in Princeton, and one in Pittsburgh.

We began by calling for opinions regarding the report and it became evident at once that if we discussed all the material presented by members of the Committe and others it would be a large task, to say the least. It seemed best, therefore, to present our report in the form of a set of resolutions, and the Chairman takes the responsibility for the statement that the report already printed in the June *Bulletin* as a preliminary report, is presented today as the official report of the Committee.

Dr. Mann's final report has been before the members of the Society for about six months and we have had presented to us from time to time very interesting and helpful progress reports. It was my idea in moving the formation of this subcommittee that we might come together this year, discuss Dr. Mann's report, and go away without having taken any definite action on his recommendations, favorable or otherwise. It seems wise then to put up, so to speak, a few lightning rods where the lightning might strike in such ways as seemed best to the Society.

The members of the Committee are agreed upon the form of the report, which I will read and then explain very briefly the separate parts.

W. E. Mott. *Chairman,* Carnegie Institute of Technology; C. S. Howe, Case School of Applied Science; L. M. Hoskins, Palo Alto, Calif.; T. U. Taylor, University of Texas; F. H. Constant, Princeton University.

The members of the Special Committee appointed "to make a study" of Dr. Mann's report have been unable to hold a meeting because of their wide geographical distribution. It seems wise to indicate in advance of the Baltimore meeting what the nature of our report will be and the chairman is therefore taking the responsibility of publishing at this time what may perhaps be regarded as a preliminary or progress report. The members of the Society who have read and discussed "The Study of Engineering Education" will realize that unanimity of view regarding the same is impossible even in a committee of five.

The purpose of presenting the report in the form of a set of resolutions is to concentrate discussion upon certain definite questions raised by Dr. Mann. It is not assumed that other important phases of the "study" should not be discussed by the Society and doubtless individual members will propose some of these other questions for debate.

Again, the six points raised are those which could perhaps be adopted in any given institution with the least amount of rearrangement of administrative and teaching machinery and may therefore be discussed on their intrinsic merits, or the reverse. We are very apt to oppose a new pedagogic proposition because we feel it will not work under our own particular local conditions.

If the sub-committee report serves to concentrate discussion and hasten action by the Society upon at least some of the vital questions raised by Dr. Mann its purpose will have been attained.

The *form* of the following report is agreed to by a majority of the sub-committee and the six items are also subscribed to by a majority, though not always by the same individuals.

It must, therefore, be explicitly stated, and understood, that the individual members of the committee are not committed to vote affirmatively upon all six items of the report, or even that all hold the view that each of the points raised should be discussed as presented.

REPORT OF SPECIAL COMMITTEE "APPOINTED TO MAKE A STUDY OF THE REPORT OF THE JOINT COMMITTEE ON ENGINEERING EDUCATION, AS PRESENTED BY DR. C. R. MANN, AND REPORT TO THE SOCIETY."

WHEREAS, The experience of engineering educational institutions, especially during the period of the war, indicates that many of the practices now adopted in the training of engineers are susceptible of modification and improvement, and,

WHEREAS, The Society for the Promotion of Engineering Education should do everything possible to advance the cause of engineering education by the establishment of standards when necessary and by active coöperation with schools, colleges and universities in carrying forward educational research and experimentation, and,

WHEREAS, "The Study of Engineering Education," prepared by Dr. Charles R. Mann, and presented before this Society by the Joint Committee on Engineering Education, has set forth the main points at issue in such plain and forceful language that engineers and educators alike have given this report most careful consideration, therefore, be it

Resolved, 1. That this Society, through its Committee on Admission, or otherwise, recommend that psychological "objective," "trade" or other similar tests be given to all students after admission to engineering courses of study and that the ratings thus obtained be compared with their subsequent scholastic progress.

2. That this Society should recommend the establishment and adoption of standards, or tests, whereby the mental growth of students and their power to assimilate and coördinate knowledge may be evaluated in terms easily recognizable by both educators and employers, such standards to be applied during and at the end of the course of study.

3. That schedules of study for engineering students should

call for not more than forty-eight (48) work hours per week (including recitation, laboratory, field work and home preparation), this time to be divided among not more than five (5) subjects which require preparation outside of class exercise.

4. That Engineering students be required to pursue courses which will develop their business and administrative qualities. These courses should involve constant or continuous training in the use of English, both oral and written.

5. That the standing committee be requested to study and report to the Society the most desirable methods of carrying on shop work instruction for students pursuing engineering courses.

6. That the Society should coöperate with the national and other engineering societies, with a view to establishing a classification of the work, or positions, including specifications as to necessary preparation and qualifications, into which our engineering graduates enter, so that undergraduate students would thus have a clearer understanding of the work for which they are preparing themselves and instructors have before them a constant reminder of the main purpose of their teaching work.

Just a word at this point. No. 1, you will notice, suggests that these tests be given the students *after* they are admitted to the schools. I think few of us are ready to accept the standard psychological tests or ratings, the Army Test, call it what you will, and accept or reject students on that basis alone. Many of us are dissatisfied with the results of our present entrance examinations. Here is a chance, it seems, to add to our knowledge of the student by testing him after he has been admitted; and perhaps in the course of a few years we shall gather data which will justify us in substituting some of these newer forms of tests for certain of our regular entrance examinations.

Some of us feel that when our students go out we have very little knowledge as to whether or not they can really use the information which they are supposed to have absorbed and apply it to practical problems. The Beaux Arts method as employed in architectural courses, problems set by this or other societies, some kind of a test of actual performance might be desirable in gauging the progress which the student has made.

Together with the preparatory schools we are interested in the question of entrance and, with the national engineering societies, we are interested in what our product can accomplish. I believe we would be justified in calling for coöperation on the part of these societies, in order to size up our product. In a sense, we do not speak the same language as the practising engineer. The statistics presented by Dr. Mann as to what the practising engineer considers the most desirable qualities which graduates should possess show that the engineers size up the candidates whom we present in way quite different from that ordinarily followed by the colleges in granting degrees. I think we should get together, and work out some method whereby the student is tested as to what he can really do both at the beginning and at the end of his course.

No. 3 is taken bodily from Dr. Mann's report, and quotes the figures presented by him as a standard amount of scheduled work to be recommended by this Society.

No. 4 falls in quite naturally with the recommendations of the Conference on Commercial Engineering held in Washington, during the last two days, namely, that all engineering students should be required to take courses which prepare them for administrative work and for business activity. Training in English, we all agree, should be emphasized and there are many opportunities to do so in courses similar to the War Issues Courses which were prescribed by the S. A. T. C. authorities.

It has been many years since this Society appointed a committee on shop work. Dr. Mann refers in his report to various methods of conducting shop work—the Illinois system, the Worcester system, the Cincinnati method, the policy at Boston Tech., and so on—and we hear constantly of the desirability of increasing contact with actual work. Is it not time for this Society to form a committee which would take under consideration the various methods now in operation and tell us what is the best way by which to carry on shop work in its broader sense? I hesitate to use the term "motivate," but I could not find a better, and I believe that shop work in the broad sense can be tied up with a great many of our courses.

No. 6 was suggested by the experience of the Committee on personnel in the Army, of which Colonel Scott was head. The first thing they ran up against in preparing plans for picking and training men for army work was the utter inability of the Army authorities to state just what were the jobs in the Army for which they needed men. They knew, of course, in a general way, as we know, what the jobs are which our students are to take up. I believe that in coöperation with the national societies, or perhaps on our own responsibility, we should formulate a list of positions or kinds of work for which our students should be prepared. This, of course, is also another suggestion of Dr. Mann's, namely, that we should keep before the students and particularly before the members of the faculty, the ideals and the work for which we are training men. Such a classification or list might be very helpful to the general cause of engineering education.

These resolutions by no means cover all the topics contained in Dr. Mann's report. The question of languages whether, or not, modern language should be included in the curriculum, questions of administration with regard to the study of the faculty itself, its organization, how it should function, and other topics of equal importance might properly be brought up. I present these resolutions on behalf of the Committee as subjects upon which we might begin our discussion. I move you, Mr. President, that we discuss these items one by one.

Discussion.

D. C. Jackson: Mr. President, for the purpose of starting this argument with a bit of a punch I am going to make a motion to the effect that the Secretary of this Society be directed to send a copy of Resolution No. 1 to the Chief Executive Officer, whatever he happens to be called, president, dean or chancellor or something else, of each engineering school in the country with the request by the Society that it be put into effect.

The President: Is that meant to be substituted for a consideration of the motion we had before on the resolution, or is it intended as a discussion?

Professor Jackson: My understanding was that we would discuss the items one by one, and my motion comes up as an entirely new matter with relation to Resolution No. 1, and I. submit it is in order under those circumstances.

The President: The motion has been made and duly seconded. Any discussion on Professor Jackson's motion? It is to the effect that copies of this first resolution be made and sent to the head of each college of engineering in the country with the suggestion that this be put into effect.

Professor Jackson: With the request of the Society that it be put into effect.

The President: That, of course, is in effect, this resolution as printed here made much more emphatic.

Professor Jackson: Mr. President, in support of that I wish to suggest that putting it in this form leaves this open for general discussion of the desirability of the resolution, and in addition thereto the desirability of getting it into effect at once. If it should be decided by the members after discussion that this resolution is not a desirable one, of course this particular motion will be voted down, and perhaps some amendment be made to the resolution itself. If it should be decided after argument that this particular resolution is a desirable one, then I think we will all agree that we should take this definitive action towards putting it into effect at an early date for test. Of course such a method as this must be recognized as an experimental move. There may be many people in the faculties of engineering schools who will hold that such methods of measuring the abilities of students as proposed here are neither effective nor even wise. Some will hold that they are unwise. Some will hold that they are a waste of time, and some will hold that they will not be effective. Personally I do not join hands with any of those. I believe that such tests as are proposed will be useful. They may not be adequate to take the place of our entrance examinations, but they should be serviceable in the way of giving the members of the faculties an additional knowledge of the individual characteristics of the students. One of the difficulties of the engineering schools which exists at the present time and which has existed for a number of years is caused by the growth in numbers. Notwithstanding the subdivision of the student body through the establishment of additional courses, which makes the individual classes smaller in proportion to the number of students than might otherwise be the fact, the truth is that classes grow so rapidly that the individual professors are unable to become quickly acquainted with the personal characteristics of the students when they merely meet them from time to time—perhaps two or three times a week—in large bodies in the class room or the lecture room. A project of the kind proposed in Resolution No. 1 should give a material aid to the professors in understanding the characteristics of each individual student, in addition to the aid not obtained from the usual markings (the A B C markings and so on) of the entrance examinations. The small engineering school, as I know from my own experience as an undergraduate, has the advantage that each individual student becomes acquainted with some one or more of the professors with a considerable degree of intimacy. And while I suppose that the teachers in the engineering school which I attended as an undergraduate student thirty-five years ago were not as learned as the average that we find in most of our engineering schools today (in view of the progress of the world), the difference to a student is very marked between, on the one hand, coming in contact intimately and personally, as we then did, with a few men of considerable learning and great earnestness of purpose, and, on the other hand, absorbing knowledge in a sort of a long distance, impersonal way— what we would call in electrical engineering ''through remote control,''—that is, by sitting in a lecture room of the kind that we are now in and listening to professors present their subjects. The latter kind of contact does not give to the students the advantages, personal influence, which after all goes towards the making of broad-gauged, well-educated men. One of our faults is our difficulty in leading our students to recognize the necessity of an engineer being a broad gauged, able and learned man. Many of us are trying to overcome this fault—I think we all are—but I think we all have great difficulty in overcoming it.

I am satisfied, as I have suggested, that to put into effect the tests here proposed in this resolution may bring results which will aid us all as teachers by giving us more knowledge of our students as individuals so that we can make our influence felt even on the individuals of large classes; and we may hereafter perhaps want to add similar tests from year to year as the men progress, so as to discover whether we are increasing the fertility and resourcefulness of our students as far as indicated by such tests.

I know that there are many teachers who may stand in opposition to the view which I express, but I hope that the motion will prevail, so that we may have the benefit of this experiment, which is a move in a new direction for most engineering schools.

W. M. Thornton: Mr. President, I do not feel inclined to go into a discussion of this report, but I would like to ask a question of the mover of the resolution, as to what the result of this action is to be. And to make that question more pointed I begin by telling you just exactly the situation in our own school. We have a Freshman class every year, the members of which go to five different professors. There are more than five, because the classes are divided into sections, but each and every student in turn receive the instruction of five professors. He has passed his entrance examinations, or whatever tests are accepted as equivalents for them. He then takes his college courses, and in December he has an examination, in March he has another, in June another. Now, my question is this: suppose that young man satisfies us perfectly as to his entrance requirements, passes all of his examinations, but falls down on his intelligence tests, what are we to do with him? Do we know enough about these intelligence tests to say to that boy's father, "Take your son away from college, he is not fit to be an engineer." And if you are not going to do anything with the results of the tests after you take them, is it wise as a question of teaching efficiency to introduce them? Is it wise for any school to impose upon the students a set of tests to which ultimately no attention will be paid? Or on the other hand it is wise to set aside the fact that the man has passed your entrance requirements, hat he has passed all his examinations in course, that he has solved all his problems, and has completed all his plates, that he had done all his survey and shop work, and turn him down because on this psychological tests he has not satisfied you? Which are you going to do? Are we going to turn him down because he failed in the psychological test, or are we going to turn down the psychological test? I think we ought to know that, Mr. President, before we say to all the engineering schools in the United States, "We recommend that you impose these tests on all students of engineering."

Professor George R. Chatburn: I noticed on the program of the afternoon that we have two reports, one on mental tests for engineering students, and the other one on vocational intelligence examinations to fourth year mechanical engineering students. It seems to me that it would be well to hear these reports before we discuss these questions because it is exactly the same question, and I would suggest that we hear these other two reports, and then return to the discussion of this particular point.

MENTAL TESTS FOR ENGINEERING STUDENTS.

BY L. L. THURSTONE,

Assistant Professor of Psychology, Carnegie Institute of Technology.

The interest of engineering educators in mental tests is perhaps largely caused by the brilliant work that was done by Professor Thorndike. The same interest among employment and personal managers and civil service boards and others is also caused perhaps by the use of intelligence tests in the army and the army trade tests. More than one million eight hundred thousand men were given mental tests, and several hundred thousand men were given trade tests to determine their trade status.

We have been working over four years at the Carnegie Institute with intelligence tests, and we have been checking up the performance of the students after they have taken the tests in order to determine the diagnostic value of the tests. We have not excluded any students on that basis. We have simply given the tests with the good will of the faculty and the good will of the students, and later on we have checked up each of the tests with the subsequent academic performance of the students. We have worked with over forty mental tests in the last four years, and in the course of a year or two we would discover that certain tests have no diagnostic value and we could cancel them or we would improve them, and we would extend, amplify and devise new tests and try them out.

I want to describe very briefly how we do that. We try to avoid personal opinion as far as possible. We have adopted the statistical procedure of the life insurance men, the actuarial statisticians, in order to determine objectively the diagnostic value of each test. We avoid those arguments for and against the tests which are based on individual cases. We do

I will be glad to answer questions on the detailed procedure of the test, and I should like to see any of you individually who may want to coöperate with us in carrying out this program this fall.

DISCUSSION.

G. M. Butler: I notice this test is not psychological. Do you give engineering students psychological tests in addition to the engineering aptitude test?

L. L. Thurstone: Yes, that is a good point. Personally I believe that the general intelligence examination is as valuable as the special engineering examination because if a student makes a high score on the intelligence examination and if he is interested in engineering, he will make good in his professional courses. I think what we really do in giving a special examination for engineering students is to give an intelligence examination with engineering content. That is really what we are doing. An examination specially adapted for engineering students is really nothing but an intelligence examination with engineering content; and the difference is that the engineering test will tap the interest of the engineering student and he will do his best. It is a little more difficult to make him do his best with an examination which is obviously irrelevant unless the purpose of the thing is pretty well explained. I should not eliminate the general intelligence examination.

Another reason for keeping the intelligence examination in our program in Pittsburgh is that the intelligence tests have been developed for four years and have established their diagnostic value fairly well.

The engineering test which I just described is a new venture and has not yet established its diagnostic value; but in another three or four months we shall have worked up the data so as to answer that question.

Wm. T. Magruder: Do you not find there is a difference in the adjustment or line or the grade of line for the psychological test and the engineering aptitude tests? (Drawing diato determine, if possible, the reason for the discrepancy between the test and the scholastic standing.

We find such cases as this: A student will make a high score on the tests and will be a poor student. We interpret such a case by saying that very likely the student is bright but lazy or he has other interests. He may have financial difficulties or other distracting interests. Now, that sort of case could explain the situation. He might make a high score on the tests and be poor in scholarship. On the other hand we may have students who make low scores in the tests and who make good in their subsequent school work. There we very often find that the student took a frivolous attitude in the tests. We also have the discrepancies caused by the bright student who is not essentially interested in the course he is taking.

The mental tests give us that much more information about the student, and when his case comes up for discussion we have not only those records but all this other information about the student. In no case do we attempt to determine the fate of a student solely on the basis of the intelligence tests.

Now, I have made some comparisons between the tests and several other criteria. I took one group of students for which we had the college entrance examination in algebra, the dean's interview rating and the high-school principal's rating. I pooled those three criteria—the college entrance examination in algebra, the interview rating and the high-school principal's interview or estimate. I correlated the result of that with the freshman scholarship and got the correlation coefficient, + 0.40 which is fairly good as these coefficients run. Then I took three of our tests for the same students, took the same grade, and I got a coefficient of + 0.48, which is just a little higher. Then, combining all six of these criteria, I got a still higher coefficient of correlation—I got + .57. In other words, our prediction of the standing of the student will be much improved if we make use of all of the available information about that student instead of limiting ourselves to the old conventional criteria.

I do not believe that we should exclude the college entrance examinations. Perhaps they may be modified in form. I do not believe that we should exclude the high-school scholarship as a criterion for admission. But I do think that if the tests by an extensive investigation establish a diagnostic value equal to the diagnostic value of the criteria that we are now using. we should be justified in adding the mental tests to the list of criteria that we are now using.

After experimenting with these forty tests we finally selected for this years program a series of eight tests, and we printed them in two pamphlets. I have some samples with me. I am sorry I do not have enough to go around. That is one of the pamphlets, and here is another one.

We printed these eight tests in what we call cycle form and gave the tests to the students. Those eight tests are the best out of forty as determined by the statistical procedure I just mentioned.

It seems to me that before determining just what weight to give to the tests we ought to carry out an investigation comparing the diagnostic value of these six criteria. We have the regular college entrance examinations, which I think should be retained, of course. Then we have the high-school scholarship records, which are probably available, and that constitutes another criterion. Then we can probably get the high-school principal's estimate of the student. That is another distinct criterion. Then if the dean of the engineering college, or some of the faculty, interview the applicant or the new student, that interview should result preferably, I think, in some sort of rating which can be quantified and studied statistically. And then we have the intelligence examination, which can be put in as one of the criteria. If it makes good, it would be retained; if it does not, it could be canceled.

And then it might be advisable to devise a special test for engineering students—a vocational engineering aptitude test, which should be so devised. I think, as to bring out those qualities of mind which the high school student should possess in order to succeed in an engineering course, but it should not emphasize too strongly those parts of the high-school course which would depend entirely on memory.

Now, if we have these six criteria, the students who enter in engineering colleges, and then later on, a year later or two years later, check up each one of those six criteria with collegiate and professional performance, we shall be able to determine just how to weight these various criteria for admission.

The preliminary indications are that the intelligence tests are at least as valuable diagnostically as the other criteria. But the final answer should be reserved until we have pooled results from a number of colleges.

Answering the question that was raised, if a single student fails in the intelligence examination, he would of course be admitted to the college. If he makes good; if he passes his examinations, of course he is retained in spite of the fact that he failed in the intelligence examination. If that happens very frequently, we have to cancel the intelligence examination as part of the admission requirements. If those cases are rare, it would do no harm, because before admitting the student we have his entrance examination, the intelligence examination, a special engineering aptitude examination, the dean's interview rating and his high-school scholarship, and so you will see that the intelligence examination is only one of the several criteria before the committee that determines whether this student is to be admitted. If he is down in all of these six criteria he would be excluded; but I should say that if he is down in any one of these criteria and fairly well up in the others, he ought to be admitted.

The tests that I have just described are the result of four years of experimentation in that line, and I feel that we are just crawling out of the preliminary experimental stage, and we are entering, I think, on a second phase of that work in which we can combine investigation with service. I do believe that we can gain valuable information about the mentality of a student on the basis of these examinations. I think that has been established, but not firmly enough to warrant us in recommending that they be used exclusively for admission. We should not recommend that.

We have made another attempt in starting to develop a test specially adapted for engineering students. This examination that I am distributing now is the first attempt, and you will no doubt notice that it is a crude one. I think that a further attempt of that sort should be made by pooling the very best judgment. such as can be obtained from this Association. And before we carry out an extensive program of that sort it would be well if the committee or committees in charge of this work could get together and devise these tests or at least go over the material before it is printed for next year's program. I should like to extend an invitation to those of you who want to use our material, to make use of the tests that we are devising for the September issue. We should be glad to have you coöperate with us in devising tests, especially tests for engineering students, and then we might give these tests on some day in September after the students have been admitted and started their college work and later in the spring of the following year collect our data for the test scores and the academic standing of the students to determine the diagnostic value of the tests.

At the Carnegie Institute our plan is to give all of the entering students a complete series of intelligence examinations as their first academic exercise. Admission will not be determined by that test. In other words, we want to test the tests before we test the students by means of them.

We try to get the right attitude of the student by giving the student the examination on his very first day in college. He is then in a better attitude to take the test and he will go after it and do his best; whereas if you give the test later on, he may not do his best because he realizes that nothing depends on it.

That is not as serious a difficulty as it might seem. I find it is easy enough to get the good will of the student by which they will do their very best.

not like to exclude or retain a test because somebody finds that this or that particular student failed in the test or made good. We want the records of all the students to count in determining the value of the test, so we plot what we call a scatter-diagram, showing these variables. One variable is the test score objectively determined. We try to arrange the tests so they can be scored by stencils and by clerks who may not even understand the content of the test. That is the ideal form of test, in which the test score would be the same no matter who scores it.

And then we plot the scholarship standing of the student. We have two different forms of criteria for determining the academic standing of the student. We have the scholarship pooled, the average scholarship in all the subjects, and also the scholarship in the individual subjects. Besides that we ask the instructors to rate each student on a scale of from one to ten, and we use these instructor's estimates as criteria for checking up our tests.

We have then these instructor's estimates, and also the scholarship grades. What we get is a diagram with one point for each student. (Diagram drawn on board.) Here we have the score in the test. Here we have the scholarship standing of the student or the average instructor's estimates. If the test is a good one, then the points will be arranged diagonally in that chart—that is, the higher the score in the test, the higher will be the rating by the instructor.

Now, there are exceptions. There are always exceptions. If the test is a poor one, then those points scatter all over the diagram; and in order to get a definite statement of the diagnostic value of the test we calculate the correlation coefficient —the coefficient used by actuarial statisticians. We use this regression line in studying our diagrams so as to avoid personal opinion.

Then, we also study individual cases, those cases which occur in this quadrant and in that quadrant, and we interview those students, and make further inquiries of the instructors gram on board.) Do you not find there is something of that kind?

Professor Thurstone: This will be scholarship and this will be grade?

Professor Magruder: And rank.

Professor Thurstone: In the test?

Professor Magruder: Have you compared them with your results?

Professor Thurstone: We have in a preliminary way. We have made a comparison between the engineering test and the instructor's estimates based on ten weeks' acquaintance. They give about the same soefficient that we would get from the intelligence tests after ten weeks' acquaintance. The coefficients are not quite as high as those we obtained after one year's acquaintance with the students. Both of the lines, based on ten week's acquaintance, are practically the same. But they may shift when we come to compare the grades in the tests with the scholarship after one year. That I can not answer yet.

Dean Butler: Do you make any difference in giving these psychological tests between the man who answers all his questions as far as he goes and does not finish up and the man who goes clear through and does not answer so well?

Professor Thurstone: Yes, we do that in this way: We score the tests in several ways. We will score a test by counting only the number of right responses in a given time. We give a time limit say of thirty minutes for the examination, and then we score the papers by counting only the number of correct responses, and then by counting the number of correct responses minus the number of errors made, and the number of correct responses minus half the number of errors made. As a matter of fact we can determine by the method of partial correlation how much to count off each error. It varies from one test to another. We do that with other tests. The engineering test which you now have is one of the new tests, and I cannot make this evaluation until I get the scholarship records at the end of this year. However, I have made that evaluation on the first two pamphlets that I distributed, and there the test scoring method is to count simply the number of correct responses in the thirty minutes allowed. Practically nothing is gained by counting the number of errors.

C. F. Allen: Mr. President, I would like to inquire in what respect this test of engineering aptitude differs from a set of questions given by an engineering professor who thoroughly understands his business?

Professor Thurstone: That is a perfectly legitimate question, and it is very easily answered. The fundamental difference between a mental test for engineering students and a test which is given at the end of his course would be this, that the test given at the end of his course depends largely on the memory of the detailed content of that course. It also depends of course on the memory of the procedure and the use of empirical formulæ and so on. In an examination for engineering aptitude the bright and talented student who has been away from high school three or four years and who only retains the fundamental concepts of physics, and perhaps the very rudiments of his algebra, would make a high score on an aptitude test because it should not require him to use material which is simply dependent on the memory of detailed facts. He is only called upon to use his good common sense in solving problems which are related to engineering. He has to use only the fundamental concepts of his high-school work. There is a very fundamental difference between those two; and that is exactly what we are driving at. If we are to use the tests for freshmen, you cannot very well test them on engineering knowledge that they have not yet acquired.

Professor Allen: Mr. President, the question may still arise as to whether the engineer, who understands his business, is going to ask questions which largely depend on knowledge. I would like to ask a question which may be irrelevant, whether this test for intelligence has ever been given to members of the faculty.

Professor Thurstone: It has, but not officially!

AN EXPERIMENT IN VOCATIONAL INTELLIGENCE TESTING OF FOURTH-YEAR MECHANICAL ENGINEERING STUDENTS.

BY WM. T. MAGRUDER,

Professor of Mechanical Engineering The Ohio State University.

During the recent 1919 inspection trip for electrical and mechanical engineering students of the Ohio State University, the remark was made by an engineering executive and employer that his company had been trying-out some of the college men that had been sent to them with the result that they found that, in a number of cases, those students who were most highly recommended by their professors as being among the very best men in the class were found to be correspondingly deficient when it came to work on the testing floor, and that they seemed to lack that quality which he termed "mechanical sense" and which used to be known by the name of "gumption" or "intuition," but which is now dignified by the titles of "vocational intelligence" and "engineering aptitude."

The reading public has heard so much of "mental tests," "psychological tests," "intelligence tests" and the like, since the psychologists showed the army how best and most easily and systematically to select men for the specific job for which men were wanted, that the idea of applying some such test to those students who were about to be graduated and recommended to the employers was not as novel as it would have been five years ago. The novelty of the so-called "army tests" lay not so much in the tests themselves as in the systematic and wholesale way in which they were administered and the satisfactory results which were obtained; for, it must be remembered that many people have been applying for centuries past their own tests for mentality and intelligence in the selection of men.

But the question was immediately asked, "What do you mean by 'Intelligence' and by 'Vocational Intelligence'? What is it that you want to find out about these students that we do not already know after having had them for three semesters in the class-room and laboratory?" Many are the definitions of "intelligence" that are now available. We suggest that it is the "ability to conceive, develop, transmit, and understand thought," and that it may be divided into general, or mental intelligence, physical, moral, spiritual, and religious intelligence. Each of these may be subdivided as one's fancy and needs may suggest. Vocational intelligence is therefore applying mental and physical intelligence to one's vocational work.

When it came to devising tests that would correctly measure some such ability, it was found that the army had not followed up the "Stenquist Construction Tests," but had relied upon the achievement tests in mathematics and English. The probable reasons therefor, we soon discovered, were due to the need for a greater number of instructors and for a much larger amount of equipment, and to the greater difficulty and time consumed in accurately grading the results.

The department was willing to try the experiment this year with a class of only ten students, left after the ravages of the Navy, the Army, the flu, and the S. A. T. C. had halved the usual class, but does not promise to do so again. Five instructors conducted the tests, or an average of one for each two students.

At the appointed time, each student was given a typewritten sheet reading as follows:

THE OHIO STATE UNIVERSITY.

No. Name..........................

A COMPETITIVE TEST OF
VOCATIONAL INTELLIGENCE IN MECHANICAL ENGINEERING WORK
GIVEN TO FOURTH-YEAR STUDENTS IN MECHANICAL ENGINEERING.

May 22, 1919. 1:00 to 4:00 P.M.

1:00 o'clock. The result of this examination will not effect your Engineering College grades. The object of this test is to determine your vocational intelligence (mental and manual) in performing certain mechanical engineering operations requiring knowledge, experience, judgment, correctness, accuracy, skill, and a coördination of brain and muscle. Each test will be graded on the amounts of these qualities shown. A bonus on each test will be given for time not used within the time limit, according to the following schedule: 50% for saving ⅔ the allowed time, 30% for half time, 15% for ⅓ time, 5% for saving ⅙ the allowed time, and proportional amounts for other times saved.

Follow the time schedule promptly. Time will begin when the question is handed to you, and end when you call time or when it has expired.

Go to the benches in the south bay of the main laboratory but do not touch the articles thereon until time is called.

Test I. 1:40 to 1:14 P.M.
Test II. Go to the Boiler Laboratory. Time to
Test III. Go to the Buffalo,
Sturtevant,
Straight Line engine. Time to
Test IV. Go to the Blake,
Knowles pump. Time to

Await your turn. If you have an idle period, use your time as you see fit, but do not go to, or observe, the tests being made.

Your cordial coöperation in the working out of these tests is requested for the mutual benefit and experience to be gained by yourself and all concerned.

It is thought that the title "competitive test" was much to be preferred to the usual title of "examination." The statements as to the "results" and "objects" of the tests and the simplicity of the first test were intended to inspire confidence in the students and thereby obtain their best efforts. The statement of the object of the test forms a good, though long, definition of "vocational intelligence." The idea of a "bonus" caused them to use their best efforts until they became discouraged and saw that they could not gain any points by extra exertion.

For the first test, each student was provided with a Crescent or Wescott wrench, a screw driver of suitable size, and a 3″ by 5″ card, reading, "Take this wrench apart and put it together correctly with the jaws in the closed position. Time limit, four minutes. Weight, 25 points." The time-limit was purposely made excessive. From 63 seconds to four minutes were required. Six averaged 89 seconds. No. 7 required three minutes. One required four minutes, and two could not succeed in getting the screw out because of lack of strength, or a pliers, with which to extract it.

On account of lack of equipment, the last three tests were made in groups, according to a schedule, and in different parts of the laboratory so that suggestion by observation was improbable.

Test II. read: "Adjust a platform scale; weigh yourself; record the result; take the scale completely apart, except the post-studs; put the scale together completely and correctly; balance the beam; weigh yourself; and record the result. The use of a six-inch screw driver and an eight-inch monkey wrench will be permitted. (They were provided.) Time limit, thirty minutes. Weight, 150 points." This was a problem in mechanics, physics and shop manipulation. That no one had ever taken a platform scale apart before was shown by the numerous wrong ways used to knock down a scale. The real use of a knife-edge in a lever was a novelty to some. The time to assemble varied from six to over 100 per cent. more than that to disassemble. One man did it in 20½ minutes when thirty minutes were allowed. Two others finished within the time limit, and four just beyond. Three were distanced. There were 38 operations. By deducting four points from the 150 total for each operation omitted, or not completed within the time, it was easy to keep the score. One student claimed that he lost a pound of perspiration in the half hour, but this was due rather to too much hurry in balancing the scales before weighing himself.

The third test was in steam engineering laboratory work based upon class-room work. The card read, "Attach an indicator to a steam engine (35-hp. horizontal) when running under load and take an indicator diagram of a height desirable for the pressure. When a diagram which is satisfactory to you has been taken, remove the indicator and put it in its box exactly as you found it. Time limit, thirty minutes. Weight, 250 points." Every student had indicated the engine with the indicator used many times during his course; but, due to nervousness, hurry, thoughtlessness, and the like, some very interesting mistakes were made and time consumed, such as in using too light a spring, too long a cord, a loose piston, or neglecting to clean the indicator before putting it away. Nineteen operations were involved. One man did it in 7½ minutes, and one in eight minutes. Several required about twenty minutes, and none over 21 minutes. This shows that the estimate of time required was excessive.

The fourth test was in stationary, steam, and hydraulic engineering laboratory work, and required a strictly working knowledge of physics. The card read: "Prepare a steam pump for proper operation; start it up and run it as it should be run, drawing water from bay no. 3, and discharging all of it at 40-pounds gage pressure into bay no. 5. Close down and leave the pump in proper order. Time limit, thirty minutes. Weight, 350 points." Every student had operated the pump many times before, but never just in this way. It required knowledge and thought to remember to see that the exhaust-pipe valve, the cylinder drip-cocks and the proper suction and discharge valves were open, that the other valves were closed, to close the drip-cocks, to start the lubricator, and to do all the 35 things that were needed to be done to make a perfect score.

The tests lasted two hours and a half, one half hour of which was wasted due to not having sufficient duplicate steam pumping sets. At the end of the tests, the records of the marks, times spent, bonuses gained, totals made, and ranks obtained were tabulated and put on a blackboard for the benefit and study of all concerned. These results created some surprises among both students and instructors. The best man in these tests made a score of 649 points out of a possible 775, and 333 points for bonuses earned for time not used or a total of 982 points. The man of lowest rank made 404, of which 21 points were obtained from excessive time allowed for the indicator test. The quick-thinking, nervous student got rattled and did not do so well as the more methodical and systematic man. The deliberate and cool-headed men came out best, especially when to these qualities was added speed. One student who had had but little shop-work and did not graduate in June in consequence thereof, was second in rank. If he had had his shop courses, he might have been first. The student who is doubtless the best in mathematical and in theoretical work and had done the least amount of laboratory work, came out near the lower end.

Before the tests, the five instructors had written down their estimates of the ranks of the students. These have been averaged and the errors summated. The coefficient of correlation is 37 per cent. From these last results, it would seem that the quiet, deliberate, diffident student is going to be ranked by estimate of his instructors below what he shows by such tests as these that he deserves. It would seem that a class-room instructor is not so good a judge of vocational and manual intelligence as is a laboratory instructor. With such tests in vocational intelligence, properly go tests of the instructors in vocational estimating and guidance. We commend to all engineering teachers, and particularly to the heads of departments, a study of the accuracy of their judgments of their students, and how that factor in their work can be improved.

It is suggested that when vocational intelligence tests are given, that they be given in the middle of the fourth year rather than at the end. We advocate the use of mental tests at the beginning of the college course and of vocational intelligence tests of all engineering students at the beginning of the first year, the end of the second year, and the middle of the fourth year.

We are well aware that no final conclusions should be drawn from such a very small number of examples, but such is not the object of this paper, but rather to get others to think along these lines, make tests of themselves and their students, and let us have an accumulation of the reports of the results.

Many similar and different tests will suggest themselves to experienced teachers, not only in mechanical engineering but in the other branches of our profession. For many years the department has used the indicator assembly test in examinations in laboratory work and obtained occasionally surprising signs of ignorance and lack of intelligence. But these have always been with a cold indicator and not on the engine. Of course, questions may be raised as to how far such tests tell us of the natural ability of the student as compared with his ability obtained by training and repetition. Might not very different results have been obtained, if their vocational intelligence had been tested by the use of instruments which were new to the students? The platform-scale test was evidently of this class.

Do such tests give one a measure of the judgment of the student, his initiative, his technical knowledge, his ability to express himself, and to argue his case? To all of such questions it may be replied that this was the department's first attempt, that no superior wisdom is claimed for these four questions, that they were not intended to try to test all branches of human mentality, nor to test the student's intelligence as a linguist, a logician, or a scientist. They are of quite limited application, and should be used with both sense and judgment so as not to injure the reputation of the student.

It is respectfully suggested that others try their hand at preparing suitable questions that can be used in college laboratories with the equipments there available, and let the Society have the benefit of their experiences.

DISCUSSION.

T. U. Taylor: I understand that there are several papers here, and I think they ought all to be presented and then discussed later.

The President: Only two, I understand, refer to this, and as we have six of these resolutions I hope we will have short discussions and to the point. We want a terse discussion.

Dean Taylor: I have serious misgivings in regard to this Question 1; however you see my name as a member of the Committee. There are only two of us here We had a conference this morning. I differed about this, about its usefulness; and for fear too much would be claimed for it I was afraid to have it printed, but I let it go through with this express understanding that we would try it out for what it is worth; and I think the limitations have been fully presented here in the discussion that followed President Thornton's questions. If we expect it to work any revolutionary results, I think we will be seriously disappointed. I only agreed that this test should be AFTER admission, and then should be used only as information for the present. It may lead to very substantial results. We hope it will. I must say that I have several misgivings in regard to it for two very decided reasons.

One of our professors who was very enthusiastic in regard to the tests was at work in our institution, the University of Texas and claimed very decided advantages for these tests, and claimed very decided predictions could be made. It is a coeducational institution, and he is very much attracted to a certain young lady, and he conceived the idea that he could apply this test to ascertain the state of her affection. A certain test was applied, and he drew very enthusiastic conclusions, therefrom, and three weeks later she married another fellow.

The President: Does that apply to engineering students?

Dean Taylor: No. The second misgiving I had was this: We had certain tests in our school of military aeronautics at Austin, and it was claimed by one of the men that they could foretell from those tests exactly what student would fail and in what week he would fail of the eight or twelve weeks' course. One of our professors went to the man that made the test himself and asked him about it. He stated no claim of that kind was ever made by any of the people that made the test, and he said that such a claim was absolutely preposterous. I had not received this information from this decided investigator when this first draft was sent to me, but I agreed to it on the lines as outlined here by the gentleman who presented the report, and I think he has covered the questions very carefully and very thoroughly: and if we will follow his suggestions there and take it for that purpose, we will file such evidence or information as cumulative evidence, it will be worth a great deal, and Professor Magruder has indicated clearly how the information could be used later. As dean of the University of Texas Engineering Department, I would say that I would dismiss no one on account of this test at the present time. While I am from Texas I am from Missouri in regard to its application at the present time.

I referred to another misgiving I had, a third, awhile ago, and for this reason: that one gentleman who is advocating these tests is in other lines, and he was called down to a bank in Austin and was notified that he had overdrawn his account. He made the happy suggestion, "I guess I will give you a check on my account to cover it."

E. J. Berg: I am in favor of these tests, and hope that many institutions will incorporate them. I shall certainly try to do so in connection with Union College. But I am very much opposed to the motion as it is put and shall vote against it. I do not like the idea of this body requesting the deans and presidents to do certain things that about which we do not all agree and about which we know so little. I wish the motion would read that we suggest to them their serious consideration of incorporating these tests rather than requesting them to do so.

Dean Marston: Mr. President I wish to say that I am strongly in favor of the resolution as it is presented by the Committee, and I do not object to the resolution of Professor Jackson. I take it that these resolutions recommend a very important educational research, and I do not think that the research of the engineering schools should be confined to the mechanical sciences. It should be extended to or attached to engineering studies.

There are some points about the recommendations which have become somewhat confused in my mind during the discussion. I hear this test debated as a substitute for entrance examinations. I have not understood that the object of the intelligence test was the same as that of the entrance examination test. I have understood that the object of the mental test was to ascertain the student's capacity for accomplishment, and not the actual accomplishment; the object of the entrance examinations is to ascertain what his actual accomplishment to date is along certain lines. He may have a high capacity for mathematical science, for example, but if he had not studied algebra and geometry and had not certain mathematical results, we would not wish to admit him to our course. I am inclined to inquire whether the proper correlation investigation should not be with the success of the engineering graduate as an engineer in the practice of his profession rather than in the grade which he attained in his classes in school. It seems to me that that would be a better correlation if it were possible to make it. We wish to ascertain whether he has the capacity to become an engineer or not; and while it may be interesting for us to be able to prophesy as to his success in class work, after all we can find that out by an examination and the actual results which he secures in a more certain manner. I am also inclined to inquire of Professor Magruder whether this vocational intelligence test is after all not primarily a test of the student's ability to do certain things in the laboratory by methods as used in a college rather than his ability to be a successful mechanical engineer in the actual practice of his profession after he graduates.

J. B. Whitehead: It is very evident that there is considerable opinion here that these tests have value. I believe that the remainder of us will subscribe therefore that it would be a good thing for as many institutions as possible to put the tests into operation.

But certainly for myself there is a very practical question involved upon which I have not received sufficient light, namely the method by which the tests will be prepared. We have heard two papers to-day, both of which have described sets of these tests. I gathered from the first paper that it has required or will require something like four years to arrive at a determination as to just what is to constitute a definite set of tests from which definite conclusions may be drawn. Perhaps I am wrong. From the second paper I judge that the tests have been prepared with the idea of ascertaining the presence of a definite quality—"gumption" as it has been termed.

Now, I should like to see included in Dr. Jackson's motion some suggestion as to how these tests shall be prepared. Are they going to be prepared by the psychologists or are they going to be prepared by the engineering faculty? It seems to me if they are to be prepared by the psychologists it might be well to ask whether a psychologist is an engineer. If they are to be prepared by the engineers how are we to go about it?

C. Frank Allen: Mr. President, there is one proposition that occurs to me with reference to Professor Jackson's motion. It seems to me we would reach more satisfactory results with relation to what we want if these tests were made in a number of selected institutions rather than by institutions all over the country. I believe that in many of the institutions where very little is known of the system it would be very difficult to conduct tests that would have any value, so that the effect would be very misleading. I have doubts as to the value of the proposed tests. There is not any doubt in my own mind about the desirability of having some tests made. I mean I doubt that it would be wise to send requests to all institutions; but it would be wise to pursue such tests thoroughly in a few selected institutions to find out what results could be obtained. If it is going to require a long series of experiments at an institution to determine anything worth while, it is very wasteful to carry it out throughout the whole of the country, when the tests could be made in a much more favorable way for those who believe in them in a number of selected institutions where the facilities for conducting the experiment to the best advantage would exist. It seems to me that we will make a mistake if we try to get every engineering college and university to attempt this, especially where they know very little about it, and where the professors probably have not, in many cases, the skill in this direction that would be necessary in order to make the experiment of value.

Professor Jackson: I think we must be careful not to become confused as to the real point here. The tests that are proposed by the Committee in Resolution No. 1 are anterior to the actual engineering course, although they are subsequent to the entrance examinations and the acceptance of the student by the engineering school. They are for the purpose of obtaining additional information in regard to certain qualities. Professor Magruder's tests are subsequent to the college training and, therefore, do not belong at this moment to the discussion of the motion which I made. Suggestions of the type of Professor Whitehead and Professor Allen are pertinent, but they do not go far enough because they are not constructive in the way of proposing modifications or amendments to the motion. I am not antagonistic to amending my motion provided suitable amendments are brought forward. There is some manner in which the thing can be worked out without causing opposition in the various engineering schools. I had in mind that the Committee who made this report should be substantially made responsible for the particular tests to be used. In answering Dean Thornton's question, we would now propose—and I think I suggested as much—relying solely on such methods; in fact I spoke of them as experiments. We must experiment coöperatively in those things. A single institution's experiments are not adequate.

Anson Marston: Mr. Chairman, the point was made that this test would require considerable time and effort on the part of institutions to carry it out. Only one hour of a student's time in one of the whole year is required to complete the Army intelligence tests. And just a few days work by one or two instructors will suffice to grade the tests. The institution gets at once a great deal of valuable information from the results without waiting for an investigation to extend over several years. The junior deans of our institutions will be helped, for example, by knowledge of the student's rating in the test when a student is believed to be deficient in scholarship in a particular class he can be advised more intelligently as to the reason; and in many other ways this rating will become of value at once. We applied all of the tests to all of the freshman in our college this last quarter, using the tests prepared for the Army. The average rating of the college freshmen was practically equal to the average rating of officers in the United States Army.

Dean Mott: Professor Allen seems to recognize in the second paper something familiar, something suggesting a civil engineering test. Dr. Thurston is a graduate in Mechanical Engineering, so that in making up and carrying on his psychological testing work, he has had the benefit of engineering training.

Wm. T. Magruder: Replying to Dean Marston, I would say that the tests that would be desired would be those that a mechanical engineering graduate would be quite probably told to make during his first or second year out of college; namely, to dismantle or assemble a machine which was new to him, to start a steam engine, to start up a power plant, to assist in the testing of it or of some of its units or appliances, or something of that kind.

Answering Professor Allen the bridge that he is considering crossing, we at our university tried to cross a few months ago. We decided that the best way was to have the examination paper prepared by the coöperation of an engineer and a psychologist. Our little experiment was viséed by the acting of the department of psychology. When you can find a psychologist who is also a civil engineer and a civil engineer who is also a psychologist, you have a leader in this work, and you do not have to spend four years in the preparation of an examination paper. We can do that for ourselves after we have had more experience in this new educational field. Until then, it might be better to follow the experienced leader. I am not authorized to speak for the gentleman whose name is on the upper left-hand corner of the three papers that have been distributed, but I am informed by a mutual friend that they are available and on sale, and that any one can get them and try out the experiment next fall without four years of preparation on his own part.

Professor Jackson: As far as my motion with regard to Dr. Berg's suggestion is concerned it would merely be to add the words "as far as practicable"—I think that would be it. Professor Allen on the other hand suggested, instead of requesting all engineering schools to undertake these tests, so that we would have the greatest variety of data for consideration, that certain selected schools should be requested to make the tests. I had not thought of that originally, but as some of the engineering schools might find it burdensome to make the tests, such a limitation might be reasonable to introduce. If Professor Allen has something to say on that, I am sure that we can get together on it.

Dean Butler: It seems to me that this subject offers vast possibilities of usefulness, more than is given to it by this program. I have one or two evidences that the entrance requirements have not been such as to show us the adaptability or our engineering students to engineering courses. I am very hopeful, and I have been working along this line for several years, that we can devise some kind of psychological test which will not only show that our students are of such a type that they can take college work satisfactorily if added to the entrance requirements, but will serve also to show us whether they are adapted to be successful engineers. For several years I have been propounding questions, formulating outlines, in an attempt to arrive at some mode of deciding whether my engineering students, after I had satisfied myself that they were capable of becoming good engineers, were best adapted to become mining engineers, electrical engineers, civil engineers or mechanical engineers. I have encountered difficulty in distinguishing between mechanical and electrical students, since these branches are closely related; and between civil and mining students, not so closely related. Enough has been done, however, to convince me that something can be done along this line. I am not in favor of using these tests as elimination tests at all. As has been said repeatedly, until they are used for a great many years we will have to use them solely as a source of information; but that information should not be merely information for us; it should be information for the student as well. Many of the students come to us with a very hazy idea of what engineering is and what that particular branch of engineering that they have happened to have entered requires of them; and I think our best work for a number of years can be along the work of advising our students whether they are in the right course and as to whether they will probably succeed in those courses. I know that something can be done along this line, and I believe it is the duty of every administrative officer in a college of engineering to do his best to see that his students are in the right pew, to see that they are studying along the right line; and entrance examinations do not tell him anything about this. His brief conference with the student may tell him something, but some questions and other tests can be devised which will tell a great deal more; and I know that there are some students, quite a number of them, who, if you tell them plainly: "I do not think you are in the right line of work," will thank you for that advice. I should like to see a special committee, or some committee already formed, take charge of this question of psychological tests or other objective tests, if you wish to put it that way, for engineering students. I do not think that we can do very much before next fall. It is all right to follow the resolution that has been offered, but I should like to see us go a great deal further than that and gather all the data available and see if we cannot find a way eventually to prevent the waste of money and time, our money and time as well as the students! I should like to see us eventually go even further and take up the question of giving the information that can be used for vocational guidance in secondary schools as well.

I should like to support this resolution as offered, but amend it by requesting that a committee or the committee that has made the report prepare suggested tests for the use next fall of those who wish to use them and probably later on I shall advocate the formation of another committee to take up the whole situation.

Dean Taylor: I foresaw some difficulty selecting a certain number of institutions by the committee, and that is this, that in several institutions these tests are already on the way by either the professors of engineers or the professors of psychology, or the two combined. They have already started. I do not think that should be discouraged. I think it should be encouraged. As to the value of these tests I am a Doubting Thomas, as I told you. But I am willing to take it as information and study it faithfully and give it a fair test. The committee might select certain schools and leave out those who would not want to do it. In selecting some schools who would want to do it, it might leave out some from which we would get valuable results, even some of the smaller schools.

I would rather see the resolution passed in its original form with the word "suggest" instead of "request." Then refer it to the Committee on Tests; and if they want any support from us they could take it up as a committee and we could make the selective list here before the whole body.

Professor Jackson: If the seconder of the motion will permit. I suggest that we substitute for the word "request" the word "suggest" and add the two words "if practicable."

R. L. Sackett: I wish to renew the motion that was not seconded. I put it in this form: I move to amend the motion of Professor Jackson by adding. "And that the President of this Society shall appoint a committee, or continue the old committee, as he sees fit, as a committee on such tests and to be a clearing house to place before the various institutions the idea." Here there is a large body of sympathy, but there is some misapprehension. At home there is a good deal of opposition. It seems to me that such a committee representing this body could advise and if an institution preferred not to experiment with it why should it be required to. I merely suggest that a clearing house committee could advise those who have any misapprehension. could easily explain some of the questions that they will naturally raise.

I have heard some opposition to the idea of intelligence tests. They were given to over two thousand students one evening. They were graded by stenographers in the course of a few days following. There was no opposition on the part of the students. They took it voluntarily. and they were much interested in the results. So far as the student body is concerned, there will be no opposition. So far as the opposition of the members of the faculty is concerned there has been much misunderstanding of the purpose. What we want, as I see it, is information available to any who are interested. and this body is the one which should collect it. classify it and have it available. I believe we shall overcome the opposition only by trying the experiment in as many institutions as possible. You will not satisfy those who are opposed until the tests themselves are put into operation in the institutions where they are. I therefore move the amendment.

P. F. Walker: I want to say a few words if I may. I expressed the idea in Washington yesterday, and I want to go a bit further. This movement which is suggested here is in my opinion the beginning of a big experiment, something which is going to take a long time to be worked out before we will get to a point where we can actually make use of the information that these tests may reveal. I think that there is a great deal of misconception as to the way in which the tests were employed in the Army. Every little while, as in the discussion here this afternoon, a word or a statement crops out which makes me believe that a wrong idea prevails as to the use made of the intelligence tests in the Army. I happened to be in command of a regiment last fall, and I believe I made as effective and as earnest use of the intelligence tests as would be possible to make in an army organization. It was not very extensive. That is, the actual serviceability of the test was not very extensive. Without wearying you I wish to comment on two or three features. This regiment was a regiment of almost green men. These men came to the organization with a few non-commissioned officers already appointed. The men went up for their intelligence tests. When the reports came back I went over them individually with the company commanders, and we found several peculiar conditions. For instance, the corporals made a better showing than did the sergeants. We found also a good many privates who made better ratings than any of the non-commissioned officers. At least a fair number of them got Grade A, the highest rating. All we could do with those reports was to take under observation those men who had shown up well in the test and wait to see if they would make good in practical work. It was true that in a general way those men who had already been selected as non-commissioned officers stacked up well. There were some exceptions, however. The reason why our corporals graded higher than the sergeants was because they were men who had already had special training and a fair education, and were really slated to become sergeants later. That is, they were the first men who had been selected by the old process of making non-commissioned officers, while the sergeants were left overs.

There is one side light shown from tests of my officers which indicates a danger that would arise from using these results with our students in too definite a way. I secured the results of the intelligence tests from a large proportion of my officers, and every man in that officer group had made a Grade A with the exception of one. That one man I do not hesitate to say was the best company commander I had in the regiment.

I am very strongly in favor of the last motion, which is in the nature of an amendment I presume, and that is that there should be appointed a committee of this organization that would be a continued committee, which will take up this whole question and carry it through in a systematic manner for a good many years. It is not an easy thing to do, and it is going to take patience and a great deal of time in order to give us a result which we can have confidence in.

I have been very much interested in this sort of a test. I was working on it for some time before the war, and I have the faith to believe that something will come from it. I believe, however, that not until a very long time has elapsed will we be able to do very much in the way of vocational guidance. The results of the tests were not used in any such way as that in the Army. We will have to be very cautious indeed in attempting to use the results of the tests of students for the purpose of determining whether or not they are suited for the engineering profession.

The President: The amendment is carried. Now, the time has arrived for voting on Professor Jackson's motion, which was that a copy of the Resolution No. 1, as printed here, be sent to the head of each college of engineering in the United States with the suggestion from this Society that the recommendations in this resolution be carried out.

G. R. Chatburn: Just a word or two. In the second line after the words, "or otherwise, recommend, that," why not add the words, "as a matter of experiment and research," so that it will read, "This Society, through its Committee on Admission, or otherwise, recommend as a matter of experiment and research that psychological 'objective,' 'trade' or other similar tests be given," and so on.

A. F. Barnes: I think that in Dean Marston's statement a suggestion was made that has been lost sight of here, and that is; that the final purpose of our tests is to find out whether our men will become good engineers—not good students, but good engineers. And I would like to see this resolution have these three words added to it at the end after the word "progress" "and professional attainment."

(The motion was then put before the members for vote and was carried.)

Dean Barnes: I move that the words "and professional attainment" be added to the resolution, being placed instead of the period after the word "progress."

Professor Jackson: How are those professional attainments to be found out?

Dean Barnes: I hesitated as a freshman in this organization to speak at all, but all the time we were discussing this matter I had hoped that someone would suggest to add to Professor Jackson's motion that this matter be taken up with our manufacturing and engineering concerns, especially our larger ones, and that they carry out studies and tests that would coördinate with ours and give us information as to whether our graduates become good engineers. It has been stated here that it would take a long time to gather data that is of value, and I think the entire movement should be started at once.

Professor Jackson: In view of the fact that most of the freshmen entering in 1919 will not be engaged in professional life for several years, we are likely to shock engineering school administrations by putting too large a matter first. On that ground I should prefer to see this amendment not carried.

L. H. Rittenhouse: I am heartily in accord with what Professor Jackson has just said. I have had in mind the proposed amendment, and recognize the desirability of comparing the grades with professional attainments. I believe, however, that it would not be wise at this time particularly to ask for this additional comparison unless we are in a position to tell in detail how this future attainment is to be measured. A long discussion could take place along this line, but I will not take your time. The manufacturers who marked the future attainments would not be equally interested. Only a few men would perhaps go to large manufacturers where the grading could be standardized. I think in the course of four years if the proposer of this amendment would get up some suitable scheme by which future attainments and advancement can be marked and graded, then it would be time enough to propose that these marks be compared with the tests. So I am opposed to this additional amendment.

Dean Walker: I rise to say a word in support of this amendment. I do not believe that we will be in a position to do any effective work whatsoever with this unless we take into account what a man is really doing and what he attains in those years after he leaves school. It is very true that a freshman will not be at work for three or four years, outside of practicing work, but I think that the committee which is taking this matter under advisement should formulate a plan to cover the whole field; and it surely will never reach any conclusion whatsoever that would help us in the judging of the possible capabilities of the men unless there is taken into account what students accomplish in practical work.

J. W. Dietz: It seems to me that if I do not mistake the reading of the second resolution this proposed amendment would fit more nearly into that part of the program than the first resolution. I rise to a point of information on that.

The President: It seems to me that that point is well taken, but I would rule that the amendment that is in order we will let the meeting decide.

(Motion was then put before the members for vote and defeated.)

The President: Are you ready for the vote on the resolution of Professor Jackson?

(The motion, duly made and seconded, was then put before the members for vote and was carried.)

Professor Jackson: Mr. President, will not one of those gentlemen who supported the last amendment lost make a motion instructing the committee which is appointed by the President to take into account all their plans of the future application of the test with respect to professional attainments?

Professor Chatburn: It seems to me that the proper way of disposing of this now is to refer it to the Council, that they refer it to a committee on intelligence tests and let this committee be a standing committee for several years.

Professor Whitehead: I move that the forms of the standards and tests which are suggested be prepared by the committee to which the first section of the resolution is referred. And moreover that the same committee prepare the standards and tests suggested in the first section of the resolution.

If I may say a word in support of my motion, I have failed to obtain from the discussion a satisfactory suggestion as to the method of the preparation of these tests. It is an obvious suggestion that engineers and psychologists should combine in the preparation of these tests; and I take it that the tests which were described in the first paper were prepared in that particular way. Yet those tests have required an extended time for a conclusion as to their value. It is suggested that in each institution an engineer and a psychologist, or perhaps a group, should prepare the tests. I believe the results from a large number of different tests so prepared would not be anywhere nearly as valuable as the results of a single set of tests prepared by our committee. The success of the Army tests is probably due in large measure to the fact that those tests emanated from one source. So the object of my motion is to get our committee to prepare the tests which come immediately after entrance and also those which are to be used through the remainder of the course.

Professor Hatt: I would like to ask if the language of this second resolution is not fairly descriptive of our present system of tests in colleges.

Dean Mott: I did not catch that.

Professor Hatt: I want to inquire if the language of this second resolution is not fairly descriptive of our present system of tests in colleges, in the ordinary examinations.

Dean Mott: I believe that it is not; at least that something more is needed, so that we prove, in addition to what we already do, that the student can pass some kind of an examination which tests his ability to quickly put into effect what he learns rather than merely test his memory, as so many of our examinations do.

Professor Hatt: I think with the language we have in the ordinary college tests it would seem to me to be descriptive of the tests that are at present being used.

Professor Taylor: I move that in the second line before the word ''standards'' we put in the word ''additional.''

The President: We have one amendment before the meeting now. That will be in order later. Any further discussion on this amendment now pending? Which amendment is that there be added at the end of the resolution, ''And that the forms of those standards and tests be prepared by the committee already provided for.'' Is that it essentially?

Professor Whitehead: That is it essentially. And that it include the tests in the first resolution.

The President: ''And that it include the tests in the first resolution.'' Are you ready for the question?

(Calls by the members of ''question.'')

(Motion, duly made and seconded, was then put before the members for vote and was carried.)

The President: Now, Professor Taylor.

Professor Taylor: The word ''additional'' there.

The President: At what point?

Professor Taylor: Right before the word ''standards'' in the second line.

The President: Is there a second to that motion?

(Seconded.)

The President: The proposed amendment then is put in the word ''additional'' before the word ''standards'' in the second line of the resolution. Are you ready for the question to put in the word "additional?"

(The motion, duly made and seconded, was then put before the members for vote and was carried.)

The President: Now, we come to the resolution as amended. Are you ready for the resolution as amended?

(The motion, duly made and seconded, was then put before the members for vote and was carried.)

The President: The resolution as amended is carried.

We now come in the regular order to No. 3, "That schedules of study for engineering students should call for not more than forty-eight (48) work hours per week (including recitation, laboratory, field work and home preparation), this time to be divided among not more than five (5) subjects which require preparation outside of class exercise." Is there a motion on that?

Professor Whitehead: I move its adoption.

The President: The adoption of this resolution has been moved. Is there discussion on that resolution?

Professor Berg: I do not like that, because it means under ordinary conditions that we would schedule our work on the sixteen hour semester basis; and furthermore it creates the impression that we think it possible and practicable and advisable to let students study as many as five subjects each or at least some days. While sometimes it might be necessary if it were to hide that fact. I do not think it would be supported by this body and shall vote against it. I do not see any particular reason why we should introduce it here. It has nothing to do with the present issue and seems undesirable.

Dean Butler: For some of us this is the most revolutionary thing in the recommendations. I had occasion to look over quite a number of college catalogues this year with this in mind, but those I looked over required a great many more hours than this. In view of the action taken in Washington we are asked, many of us, to reduce the number of unit hours in our course by as much as eighteen, and that is not a simple matter. It is going to mean revolutionizing our courses. I think engineers can study profitably more than sixteen unit hours a semester. I had occasion this year to go over the records of our students for four years, and proved conclusively that in many cases the man who had eighteen hours did better work than the man who had fourteen or fifteen. Engineers have to work and hard after they get out of college, and they should acquire the habit of industry in college. If we train them in the idea of working only eight hours a day, they will be handicapped when they get out of college. Every one of us works ten and twelve hours a day. It is going to furnish ammunition to our "enemies" in the "cultural" departments if you say that we require our engineers to work too hard. I am proud of the fact that our engineers work harder than the other students. I am aware that engineering courses are more difficult than others and should only be taken by men of better than average mentality. I would hate to see it stated definitely by a body of this standing that engineering students are not capable of assimilating more than sixteen hours of work.

Professor Mott: I just want to correct Professor Berg that the intention is that there should be five subjects daily. It means that there should be five subjects carried through one quarter or semester.

A. S. Langsdorf: This is the one paragraph in the report to which I take serious exception. I do not believe that the colleges of this country are going to back up the notion of the eight hour day in education, especially in engineering education. Many years' experience in teaching work has convinced me that it cannot be done, and I wish to serve notice that whether the Society adopts the recommendation or not, the institution with which I am connected will most decidedly not follow it.

At Washington University we have recently made a very careful study of the curriculum in force prior to the S. A. T. C. period, and with the experience during the war as a guide, we have mapped out an entirely new course of study. We find that we cannot make it effective by adhering to the number of hours proposed in the report of the Committee before us. Seventeen to eighteen hours per week seems to be the irreducible medium, and in the case of freshmen we have tried to temper the wind to the shorn lamb by beginning with seventeen and working up to eighteen, and in some departments up to nineteen hours in the senior year.

Dean Marston: I see no reason why an engineering student should not work fifty-four hours.

O. M. Leland: I should like to state that I see no relation that is exactly fixed between the forty-eight hours that are referred to and sixteen credit hours. The previous speaker seemed to think that a ratio or factor of three is involved here which limits credit to sixteen hours per week. I know that in some institutions two and a half hours are required, or are considered equivalent to a credit hour. I should like also to state that I do not believe that there are many institutions where a teacher can determine whether it is two and a half or three hours that a student devotes to any one lesson. I do not see anything wrong in specifying forty-eight hours here if you count two and a half hours. That makes twenty hours of credit. You can put any number of hours you wish upon it. I think the intention is to standardize a week's work as far as possible. I see no reason why forty-eight hours should not stand.

J. J. Flather: I rise to a point of information, whether this includes drill, or whether drill is to be included as gymnasium exercise and as recreation?

Professor Jackson: I had nothing to do with the formulation of this resolution, and I may be wrong as to its intent. But it impressed me that perhaps the Committee had in view limiting the scheduled work, with the expectation that it would afford the better students an opportunity for working in colateral studies, or doing collateral reading, which is so very important in engineering education. I am satisfied that many of our engineering schools are at the present time overworking their students, not so much from the standpoint of injuring their mental vigor or physical health, as in the keeping of their minds chained tō the subjects assigned in the recitation room or the laboratory or in the drafting room, and doing very little in the way of encouraging collateral reading on the part of those students who can carry their work with relative ease. If this resolution has that intent, I want to submit that it is a very wise resolution; and if it is misunderstood on account of its phraseology, it might perhaps be improved by altering it.

C. R. Mann: I just want to remark that Professor Jackson's interpretation is correct. What I intended by forty-eight hours is scheduled hours. There is a large factor of safety there, because in most institutions forty-eight scheduled hours means anywhere from sixty to seventy-two hours of work for the student to keep up with the schedule. It is very essential to put a limitation on the schedule made by the faculty because the students never keep up with the schedule in actual practise. As Professor Jackson has said, in his institution, which is on a forty-eight hours basis, the boys work from fifty-four to sixty or even seventy hours per week. So it was not intended that the boys should work only forty-eight hours a week, but that the schedule should call for not more than forty-eight hours, in order that the boys might have time enough for thinking and for thorough work.

L. A. Hazeltine: I wish to join Professor Jackson in approving the principle of this resolution. Stevens Tech has for a long time worked under a schedule of forty-eight hours a week, an duor course, I think, cannot be accused of lack of thoroughness or completeness on that account. We are able to do this by assigning only one hour of home preparation for each lecture or recitation hour, having eighteen lecture or recitation hours a week, eighteen preparation hours, and twelve hours of practical work (laboratory, shop or drafting). Very frequently, I believe, the expectation that students study two hours at home for every class-room hour is an illusion. We should face the facts and tell the students what we really do expect, and not hold up an ideal which neither we nor they take seriously.

Professor Magruder: I would like to ask Dr. Mann and Dean Mott if this resolution means what it says, that each of the forty-eight hours is to be scheduled and that Mr. Student is to report at a certain definite place every evening to do his studying for the next day under supervision?

Professor Jackson: He ought to report at home or some such place to do his studying not appearing on the schedule.

Professor Magruder: The reason I ask the question is that one of my colleagues before we had heard of the S. A. T. C. suggested the scheme of having the student report at the laboratory or some other place wherein he should do his studying and working out of problems under the supervision of an instructor.

Professor Jackson: Are we to consider our students children?

Professor Magruder: The idea was not to see that the men were there, but rather to see that they should receive proper and adequate supervision in their work. Just as you would schedule two or three hours for drawing room work and have an instructor supervise the work, so you would schedule an hour or more for working out examples, working out problems and things of that kind.

Professor Danforth: I think a great many of the people that we talk about are getting some of the things Dr. Goodnow spoke of some time ago. We are not only getting graduates in engineering, but we want them in this plastic nature in their lives, and we have to give them time to form their lives. We can help them in some respects by guidance of one kind or another, but they have to learn things outside of the engineering field. That means student activities. We are beginning to believe that we turn out men who succeed better in the long run out of school if during their school years we give them a reasonable amount of time for student activities and give them credit for what they do, just exactly as they do for class room work. I would like to have the people who were discussing this thing stop to think for a minute—how much time can you give a man with a fifty-four-hour schedule for the big work of his life, to develop his own character?

Dean Butler: Mr. President, I am speaking in self-defense. I am very envious of the schools that are in a position to say that one hour of credit shall mean whatever seems fair and desirable; but there are some of us not in that class. Our ratio has been fixed largely by those outside of engineering departments. In our school it means three to one and we cannot change it. I do not claim that our men should do more than fifty-four hours' work, but they can handle that much; yet, if this goes through, I am sure that I am going to have a schedule of sixteen unit hours of work, and I know that is the case in other schools.

Professor Berg: Mr. President, just one word. I am opposing any standardization in engineering courses. This is a tendency in that direction. There ought to be many kinds of engineering courses. This laying down of laws that we must divide the time a certain way, devote so much to so many subjects, is undesirable, it is something that should be decided by each faculty, depending upon characteristics of the professors and teaching staff.

Dean Walker: Before the question is put I want to point out something that is probably ambiguous. This resolution states that the total work shall not cover more than forty-eight hours of the work in exercises. That is, if there are some subjects requiring no outside preparation, the student's total time required is not more than forty-eight hours a week. I move to strike out the words "to be divided among" and substituting the words "to include," so that it will read "this time to include not more than five," etc.

G. C. Anthony: It seems to me that it is a very unfortunate motion. In the first place we are dealing with units that we cannot agree on. We have a schedule hour and we have the term hour, as some of us call it. We have already arranged this thing in our institution at the bottom rate of seventeen term hours, which means fifty-one working hours, approximately, and which varies all the way from forty-eight to fifty-five or sixty as the case may be.

We are working upon a unit that we cannot determine for all institutions, and we will be doing well if we determine it for our own institutions.

The motion to reduce the number of subjects which are carried at one time would be a very great improvement, and in our faculty at Tufts College we have been attempting to enable the curriculum to be so designed that it will reduce the number of subjects in the freshman program to four, and in the upper class to five. I am very much opposed to the motion as stated and will vote against it.

(The motion, duly made and seconded, was then put before the members for vote and was defeated.)

The next in regular order would be Resolution No. 4, "That all engineering students should be required to pursue courses which will prepare them for administrative duties and for responsible and effective citizenship. These courses should involve constant training in the use of English, both written and oral." Is there a motion to consider?

Dean Sackett: I submit that the last sentence is practically an impossibility. "These courses should involve constant training in the use of English, both written and oral."

Dean Taylor: As a member of the committee I can state what I had in mind, and I think what the others members had, was not in the junior and senior year they should take a course in English, but carry it out as we do in the University of Texas, that is, every examination paper may be submitted to a standardization committee. We have a standing committee on the student's use of English, or whatever you wish to call it. Sometimes a student who has passed English in his freshman and sophomore year thinks he has finished it all, and he gets so loose in his subject that we have to pass his paper over to that committee. I think that is what is contemplated, that any paper is subject to the committee on English.

Professor Berg: It is true that ninety per cent. of the engineering students expect and hope to be managers and administrators. It is a rather regrettable thing. I think some students, at least, or indeed a great many of them, ought to be trained so that they would love engineering for the sake of engineering.

I do not like the way this reads. It was a great surprise to me to find that about fifty per cent. of the engineering colleges were not giving any courses along lines of economics. That is of course entirely wrong, some course in economics should be included in every engineering curriculum. But I would like to eliminate that word "administrative duties" from this part of it and suggest that we state instead that all engineering students should be required to pursue some courses in economics.

Professor Berg: What I want to bring out is this fact that our engineering courses should contain the fundamentals of economics. That is important, but it is not important that they should contain courses that lead to administrators' positions.

G. R. Chatburn: While coming in on the Pullman, the day before yesterday, the first night out from home I fell in with an alumnus of my own college, who is now a practical mining engineer in the West and a very successful man. He was on his way to New York City with a half dozen other men who were the heads of large business institutions; he told me that not a single one of those men, and a great many others that he had mentioned, had ever graduated from a college, and he wondered why it was that our engineering students did not become the heads of large institutions; he thought, and it seemed to me that his ideas were well taken, that we should put into our engineering courses something that would lead to administration that would develop administrative ability, so that college graduates would become the heads of the big business concerns of the country instead of those places being taken up by men who had grown up in the service.

Professor Jackson: While this resolution is to be applauded in its intent, its phrasing may leave the inference that the present subjects are not preparing our students for responsible and effective citizenship. Now, I want to deny that very emphatically. I wish to urge the proposition that the engineers as a professional body are as effective in citizenship and as responsible as any professional body in the world. If the resolution is carried, I wish to urge an amendment in this form, immediately after the word "will" insert "have as the direct object," and then change the word "prepare" to "preparing," so that it reads, "all engineering students should be required to pursue courses which will have the direct object of preparing them." In other words, recognizing as we do that the subjects which our students now follow do prepare them for thoroughly responsible citizenship, yet we also recognize that it is desirable to have some subjects in the curriculum which have particularly that one object in view.

Dean Mott: I agree with Professor Jackson that our men carry on administrative duties and are effective citizens. However, I do submit that most of our engineering students and graduates, when they leave us, are not properly trained. Many of them may talk about the "Maguires" of Hungary; they know very little about either our home or foreign relations.

Professor Berg: I am going to talk against that amendment because I do not think engineering students should have that course. Most of us who have made out schedule for engineers know the difficulty at the time. Here all of a sudden this body decides that all students should be given a course in administration. Perhaps ninety per cent. should have it, but it would be unfortunate for all. Some institutions at least ought to concentrate on scientific engineering which requires a great deal of time.

Dean Walker: If a substitute motion is in order for the whole proposition. I wish to submit the following. below paragraph 4. that the S. P. E. E. looks with favor upon the movement to have an effective business course made a part of the course of study. This should involve continued training in the use of English.

The President: I understand that is proposed as a substitute motion for this resolution. I will rule if it is satisfactory, that the substitute motion now is before the meeting.

Dean Sackett: Mr. President. I wanted to suggest that it is not more constant training in English but more effective training in English that is needed.

The President: Will Professor Walker state the motion once more?

Dean Walker: That the Society for the Promotion of Engineering Education looks with favor on the movement to include business training as part of the course of study. This should involve continued training in the use of English.

Professor Magruder: I would like to get a definition from Dean Walker. Do you mean stenography and typewriting and banking and making out each other's checks and such things that we have in a business training schools.

Dean Walker: I mean the class of courses which are recognized in the established schools of commerce in a large number of universities.

Professor Berg: Courses along economic lines, would that suit you?

Professor Magruder: Would you be willing to consider this: a course in business administration. which would include the lower as well as the higher?

Dean Walker: I believe we will be closer to the standard rules and standard scope of courses such as have grown up in the universities. with particular reference to the schools of commerce if we do not use a word so closely definitive of scope as administration.

Professor Magruder: What I would like to see. Mr. Chairman, is a course added in the humanities. By that, Latin and Greek, the humanities as we know them today in our colleges of commerce—not commercial schools, but in our colleges of commerce. Begin with economics as a foundation stone and come up. Begin with political economy, that is, the political side, and go on up so that when a men gets out into the world he will know something about labor troubles, he will know something about what rights he has as a citizen in his commonwealth.

Dean Walker: That is exactly what it means.

Professor Magruder: Will you kindly put that into English of our understanding?

J. C. Tracy: It seems to me we should be rather cautious in passing any resolution in regard to this without first knowing what was done in Washington yesterday. A resolution carefully prepared after two days' conference in consultation with business men was passed and I believe that we are in danger of passing a resolution which may conflict with that. Take. for example, the term business administration. Business men present at that conference rather seriously objected to the use of that term; and I think it would be wise if this could be laid on the table for the present and perhaps taken up again after the resolution, which was originally prepared I think by Dr. Mann, has been read and considered by this Society.

Dean Turneaure: At one of the meetings along this very line it was recommended that engineering schools should proceed in the training of engineers for commerce by the extension of courses in economics. Now, I am lost because I do not remember the words used. But I think this resolution can be resurrected in a day or so; and if this matter was referred back to the Committee, I think we could bring in a resolution that would harmonize with the resolution passed yesterday.

The President: The question is then to recommit this particular resolution. No. 4, to the Committee.

(The motion, duly made and seconded, was then put before the members for vote and was carried.)

The President: The motion is recommitted.

We come then to No. 5. This resolution is, "That a committee be appointed, to study and report to the Society, the most desirable method or methods, of carrying on shop work for students pursuing engineering courses, so that such shop work shall motivate as many of the courses of study as possible." It is a motion to appoint a committee.

Professor Hatt: I wish it might be broadened. It brings in the very important study of motivation of the student, as I read Dr. Mann's report, and with the consent of the committee I would like to modify that resolution to read as follows: " That a committee be appointed to consider and report to the Society the methods of instruction, particularly in shop work, by which motivation of the student may be accomplished." The hour is getting late. Otherwise I would like to say a few words on that subject of motivation, but I think we all understand what is meant by the term.

Dean Barnes: What does the term shop work mean as put in this resolution. I want to ask what the term shop work means?

Dean Mott: The term shop work as used here is intended to cover work in the carpentry shop, foundry, machine shop, and it is a term used to cover shop work.

Professor Berg: Mr. President, I am ashamed to rise again, but I am a practical engineer and also a teacher. I have no objection to voting yes because after all we are only to appoint a committee. It is a different thing to accept committee's recommendation. And I am sure the committee will realize that there are as many different colleges and that we are endeavoring to do many different things, so that the certain shop work for one electrical engineering course cannot possibly be the best for another.

Professor Hatt: The Substituted motion is "That a committee be pointed to consider and report to the Society the methods of instructions, particularly in shop work, by which motivation of the students may be accomplished."

(The motion, duly made and seconded, was then put before the members for vote and was carried.)

Professor Jackson: Was that not a vote on the substitution of Professor Hatt's motion for the original resolution? I supposed we would have another chance at the resolution before its final passage.

Professor Jackson: On account of ambiguity of the phraseology as it now stands, I urge that the resolution should be re-referred to the Committee.

(The motion, duly made and seconded, was then put before the members for vote and was carried.)

The President: Now, we come to No. 6. "That the Society should coöperate with the national and other engineering societies, with a view to establishing a classification of the work, or positions, including specifications as to necessary preparation and qualifications, into which our engineering graduates enter, so that undergraduate students would thus have a clearer understanding of the work for which they are preparing themselves and instructors have before them a constant reminder of the main purpose of their teaching work." Is there a motion to approve this resolution and pass this resolution?

Professor Berg: I am sorry I have to speak again. I think you must agree with me that it is quite impossible for any body of men, I do not care who they are, to make out a list of what engineers are going to do. It is impossible to say what electrical engineers are likely to do. I have been in the practical engineering business for twenty years, and feel that I understand its features. It would be different if we were dealing with vocational training, a straight school proposition. We might know what the blacksmith needs, or something like that. But we are dealing with engineers who are going to face every conceivable position. I do not think that it can be done, and am against it.

H. B. Shaw: I would like to make a suggestion that the object of this No. 6 could to my mind be better determined by each institution getting a picture of what its graduates do after graduation. And I think you would find coöperation from the employers of those graduates, particularly those who employed them in considerable numbers.

J. P. J. Williams: I suppose that most of you know perhaps that the Engineering Council at the present time has a committee working on the question of classification of engineers. and they are making a deliberate attempt to place engineers in various classifications in connection with the matter of compensation.

I would like to call attention also to Dr. J. A. L. Waddell's suggestion in the symposium which the *Engineering News-Record* had recently. He suggested that the S. P. E. E. should appoint a committee composed of eight men. four professors of the engineering college and four practising engineers; and it occurs to me in this connection that that kind of a combination committee should be appointed which will bring together the academic efforts of the professors and the demands of the practising engineers.

(The motion. duly made and seconded, was then put before the members for vote and was carried.)

The President: The motion is made to refer it to the council, the matter of arranging for carrying out this resolution.

(The motion, duly made and seconded, was then put before the members for vote and was carried.)

MILITARY TRAINING IN ENGINEERING SCHOOLS.

BY COL. F. J. MORROW,

Chairman, Committee on Education and Special Training of the War Department.

In April, 1917, when the United States entered the war it was but little prepared to undertake military operations against a first-class power. The National Defense Act of 1916 had increased the size of the Regular Army to 175,000 men, to be provided in five annual increments. But one of these increments had been added. In every one of the scientific and technical branches, the Army was deficient both as to personnel and material. Agitation favoring military preparedness had been carried on by a small group who saw clearly that our participation in the world conflict could not be much longer postponed, but the great mass of the people did not see the necessity for it. They saw in preparedness the spectre of militarism, and to militarism they attributed the conflagration which had burst forth in Europe in 1914. With the entry of America into the war it became necessary to immediately devise a scheme which would give us the immense army of trained men necessary to make our participation effective. To the eternal credit of our legislators they declined to be satisfied with voluntary service. The passage of the draft law effectively democratized our military effort. It brought home to the American people the idea that every citizen who shared in the benefits of our democratic system must be prepared in his turn to render military service. The passage of the draft law was made possible largely through the influence of thousands of business and professional men who had come to realize the ineffectiveness and waste of effort involved in any other system. Perhaps the most effective work along this line was done by those who had attended the Plattsburgh camps. The value of that movement can hardly be overstated. The men who went there became convinced that the making of a soldier is more than the mere uniforming and equipping of the citizen. The consciousness of this fact carried with it the realization that America had very few trained men to lead a large Army and in consequence those business men exerted their influence to correct this state of affairs.

To be reasonably well prepared for a war which can not be honorably avoided, does not mean that we must burden ourselves with a military system so vast that it threatens our democratic ideals or our republican institutions. There is a happy mean between the bristling menace of Prussian militarism and the helpless impotence of China. It is an inspiring thing that an unmilitary, undisciplined and peaceful people should have been able to raise, equip and transport across the ocean, a gigantic and formidable army. The fact that we succeeded in accomplishing this task must not blind us to the danger we incur if we surrender ourselves to the snug thought that we shall always be able to successfully duplicate that feat. The United States in 1917, and Great Britain in 1914, were able to create immense armies because they were given time for organization, and for the manufacture of equipment and munitions. The boundless resources of America and the deep-rooted loyalty and patriotism of our people would have availed humanity but little had not French, British, Russian, Italian and Belgian armies and the steel walls of the British fleet held off the foe until the hammer, which was to crush him, could be forged at home.

The day has passed when the 3,000 miles of rolling Atlantic and the vast expanse of the Pacific will insure to America her "splendid isolation" and absolute immunity from foreign invasion. Only a few days have passed since we have read in the papers of the latest aërial achievements which bring America and Europe within sixteen hours of each other's shores.

Intelligent and far-sighted statesmanship charged with the direction of our national affairs must determine what measures will provide that balance in national preparedness to which I have referred.

Perhaps no government in the world is more sensitively responsive to the trend of public opinion than our own when it is once clearly manifested. The power of public opinion in determining the policy of the executive and legislative branches is most potent. Most of our newspapers are reflectors rather than moulders of the views of the people. The direction and guidance of the great force known as public opinion, lies largely in the educated men and women of the country, and the educated men and women of America are the products of our collegiate institutions. The college graduate has, therefore, a heavy responsibility and his teachers have a greater one. Can it be denied that at the door of our educators lies a part of the responsibility for the public opinion which approved—or at least failed to forcibly disapprove—the state of unpreparedness of our country previous to the war?

Few of the leading educators had seen the writing on the wall, the need for military training in the schools was not appreciated, and some were actively engaged in discouraging any preparation for national defense. Many thousands of graduates were going forth annually and entering into the life of the nation without having acquired any preparation for any particular form of service.

Today, with the experience of the war behind us, necessity for a closer affiliation of the colleges and the War Department seems to be generally appreciated. Past deficiencies and the heavy price which must inevitably be paid for the neglect of thorough preparations are clearly recognized. It can be said that our country in times gone by did not benefit itself from its participation in previous wars; that as soon as the sad experience had passed we began promptly to forget it and to conduct ourselves as though there would never be another.

It is an encouraging sign of the times that today there is a determination that we shall take permanent advantage this time of our deficiencies in preparation. One form in which this determination manifests itself is in the preparation of college men for possible future service. In *your* hands lies the opportunity for developing in your graduates a spirit and capacity for service. The educational world should feel a responsibility for imparting to America's youth an intelligent understanding of our country's problems of defense.

The Government has established a liberal, comprehensive and workable system to assist schools and colleges, and it desires to coöperate with them, sharing the problems of instruction and largely assuming the financial burdens. It does this through the Reserve Officers' Training Corps.

The R. O. T. C., as it is commonly called, had its inception in the National Defense Act of June 3, 1916, and in the fall of that year it began to function. Before the close of the first academic year came the declaration of war and thousands of the students, including practically all the cadet officers, flocked to the training camps and the recruiting offices. The organization finished the year as best it could and prepared to carry on in the fall of 1917 with the instruction largely in the hands of retired officers who were recalled to active duty for this purpose. Towards the close of the war the R. O. T. C. had been largely replaced in the colleges and universities by the Students' Army Training Corps which had taken over 102 of the 123 units nominally in existence. With the signing of the armistice and the subsequent demobilization of the S. A. T. C. these units were automatically restored to their former status and the growth of the R. O. T. C. from then on has been rapid.

Since November 11, 324 new units have been approved and are now in the various stages of organization. Over and above the 494 units now in existence, there are 89 applications on file.

The 494 units which I have mentioned above are distributed through 336 institutions in every state in the Union and in Hawaii and Porto Rico as well. There are. I believe, approximately 126 institutions in this country in which engineering education is offered. Of these 99 will be found to maintain units of the R. O. T. C. Four others have made application. The 99 units already established are divided amongst the various branches of the service approximately as follows:

Coast Artillery	23
Field Artillery	20
Machine Gun	2
Engineers	16
Signal Corps	21
Infantry	93
Cavalry	3

Of these, the Engineering, the Signal Corps, and the Coast Artillery units absolutely require engineering courses and this will also be true of Ordnance and Motor Transport Corps units when they come to be established. Engineering institutions are, of course, also favorable for the units of all services.

It has been determined that to supply the necessary technical officers for a citizens' reserve army of 5,000,000, an annual increment of about 7,000 such officers must be provided. Modern warfare makes an insistent and constantly increasing demand for officers with technical training. It is of vital importance that these men should have if possible such training as only engineering colleges can afford. Before the war our engineering schools graduated annually about 4,300 young men. Of these a percentage would not, for physical and other reasons, be qualified for military service as officers of the Army. It is probably safe to say that not more than 3,500 could be counted on as eligible for commissions in the Officers' Reserve Corps each year. This number provides us with one half of those required. If even this half is to be made available it means that every student of engineering must be enrolled in the R. O. T. C. and encouraged to seek a commission in the Reserve Corps.

While the engineering schools render such a contribution to the country they should receive certain substantial benefits in return. It is particularly noticeable in the case of engineering courses that they do not require much modification in order to be of military value. It is necessary to partially shift the emphasis and to introduce concrete problems and applications of a military nature; this military subject matter will add interest and value to the courses without detracting from their general academic worth. The use of the engineering courses as a part of the training for a reserve officer will furthermore contribute an added incentive to the students, and will inculcate in them at the same time a sense of civic responsibility and national service.

The marked improvements in the morale, esprit, and general disciplinary bearing of the undergraduates in schools where the R. O. T. C. has become a part of the institutional life has been generally noted with satisfaction. It has been made evident that military instruction tends to produce better coördination of mind and body than athletics, it inculcates firmness and decision of character, respect for law and authority, quick thinking, and alertness of mind.

There are certain special problems which arise in connection with the introduction of the R. O. T. C. into engineering institutions and I should be very glad of your assistance in their solution. I shall confine myself to two. First, there is the problem of overloaded schedules. This is solved in part by incorporating in the military program, those subjects which form part of the academic program. There remains the necessity of providing a certain amount of time outside of the study periods for *physical training*. I think you will admit that a good physical set up, good carriage, powers of endurance, the habit of physical activity and self-care are essential to every man, civilian or soldier. It does not seem unreasonable to ask every young American at the formative period of his life to devote at least two hours per week to the development and establishment of good health. Secondly, the reduction or abandonment of practical military exercise during the academic year requires special emphasis upon summer camps. Several difficulties arise here. The student who depends on his summer earnings for funds with which to pay his way through college finds it difficult to give up his six weeks of the summer to camp training. In the case of some institutions, there is the added difficulty of continuous academic sessions, summer schools and summer shop work or engineering camps. I feel sure that we can in some way reach a solution of this difficulty; perhaps by combining all the camp work into a single three months' period, so as to leave all of the summers free but one, which might, if necessary be the summer after graduation.

These are difficulties with which we are contending and on these and on all other matters I shall be grateful for your advice and help.

THE PROBLEM METHOD AT THE ENGINEERING SCHOOL, U. S. ARMY, CAMP A. A. HUMPHREYS, VA.

BY MAJOR C. C. MORE AND CAPT. W. E. DUCKERING,

U. S. Army.

The primary purpose of The Engineering School at Camp A. A. Humphreys, Va., is to stimulate and encourage the student in the exercise of his power of independent thought, reasoning and judgment, and to increase his ability to cope with new situations when confronted with them in engineering practice, rather than merely to provide him with a fund of engineering information and abstract theory, valuable as the latter are as adjuncts in his training. This purpose was laid down as a guiding principle at the very beginning, by the Chief of Engineers, Major General W. M. Black, and was emphasized continually by Colonel V. P. Peterson, Commandant of The Engineer School. In the half-year ending June, 1919, under the personal direction of Colonel Earl North and with the enthusiastic coöperation of the instructors, this object was attained in the Department of Mechanics of Engineering, by the use of methods similar to those which have been in successful operation during the past six or seven years at the University of Washington, Seattle. (The Washington method of teaching mechanics is the outgrowth of several years of experimentation carried on with the enthusiastic encouragement and support of Professor A. H. Fuller, then dean of the College of Engineering. A brief description of this method is given in an article by W. E. Duckering, in *Engineering Education*, May, 1917.)

The major portion of the classroom work was devoted to stimulating mental effort on the part of the student, and to training him in practical methods of attacking, analyzing, and solving engineering problems, instead of being devoted to the usual methods which attempt to cover a set amount of text-book material, and center instruction around that purpose. The student was encouraged to use his own judgment and to make use of ideas which had grown out of his own previous experience. An endeavor was made to lay the foundation for future effort within the student himself, rather than in a text which he could carry under his arm. Every encouragement was offered to the development of what may be called the ''engineering mind.''

In this method there are two definite phases of the work: First, the phase in which study problems are used, and second, that in which drill or training problems are used. Study problems were designed for purpose of analysis rather than synthesis, with concrete engineering situations used as a basis. Where feasible, the objective ideas corresponding to technical terms used by engineers were presented by means of visits to actual engineering structures. In this manner the students were enabled to more easily visualize and understand the technical language of the engineer. For example, a bridge was visited before the first study problem was taken up. The names and functions of the various parts were discussed, and the question was raised as to the path traversed by a load placed upon the bridge, as it is transmitted through the members of the bridge, from its point of application to the ground. This introduced one of the fundamental principles of engineering thought into the minds of the students at an early stage in their training. This visit to the bridge was not made for the purpose of analyzing that particular structure but to introduce the subject of structures in general. The subsequent class-room work dealt with a different type of bridge and during the course many types of bridges were used in problems, so that the student would not be limited, in his idea of bridges in general, by the one that he happened to inspect first.

In the classroom, the first definite study problem dealt with a pony-truss span, for which were furnished the usual engineering detail drawings showing all dimensions and sections. Military necessity required that a certain heavy howitzer be taken across the bridge. The question was asked: "Is the bridge, in its present condition, safe for this load?" With the situation before them, the students were turned loose upon the analysis of the problem. The next step, following naturally from the discussion held at the bridge site when inspecting the structure in the field, was to determine how the structure might fail. Each student was required to use his own ideas and make a list of possible sources of failure. These lists were taken up for general discussion, and from this as a starting point the students were led step by step to investigate the various members of the structure. The necessary theoretical analysis was introduced whenever required. The hanger and both chords had purposely been designed too light, thus adding an element of interest to the search for possibilities of failure. When the students discovered these members to be unsafe, they were asked to redesign them in accordance with standard specifications. Naturally, some phases of the analysis seemed too intricate for immediate treatment in the class; but these were easily deferred. For instance, in the case of the floor system, the investigation was carried to the point where the worst positions of the load were decided upon, and sketches were made showing the probable manner in which the planks, stringers and floor beams would break, but the determination of the actual fiber-stresses in these members was deferred temporarily with the understanding that it would be gone into carefully in subsequent discussions. However, the class was led to make recommendations concerning means of strengthening these parts of the bridge in case they were found to be unsafe.

At every step in the analysis of study problems, the many possible assumptions underlying the mathematical computations were always discussed at length by the class, and often two or more assumptions were taken as a basis for mathematical analysis before the students were encouraged to make final judgment concerning what appeared to be in line with the best practice. In this manner the student is made to realize that engineering is not an exact science, and the element of judgment plays a very important part in all engineering problems. He also starts his career with a more open mind and a greater capacity for making advances along new lines of engineering thought. He develops a keen interest in engineering literature, especially current engineering periodicals and papers and discussions of engineering societies. Students are not subject to the limitations of a single text, but find it advantageous to refer to several. An inevitable result of this kind of training is the tendency of the student to rely more and more on his own judgment with respect to making assumptions, and in all his work the student shows a greater self-reliance and an increasing desire to do independent thinking.

The chief purpose of the drill problems are to furnish vehicles for training, and for fixing the use and understanding of the fundamental principles firmly in the mind of the student by well-directed repetition. Practically all review work had these purposes in view, though it was possible to use these problems as a means of grading the students and of giving them their section rating. The purpose of these problems, held before the mind of the student, is the opportunity to set up good habits of analysis and work, and to increase by means of carefully organized and well executed computations and sketches, his power to get accurate results and develop speed, while at the same time each problem makes him more at home in the use of the necessary mathematics and mechanics. In order to aid in the accomplishment of these purposes, the major problems were broken up into a large number of subproblems so that the arithmetic might be made easy and so that particular attention might be directed to a great variety of special uses of the fundamental principles. In order that the student would know how to organize his work with a view to the development of speed and accuracy in execution, and as an aid to clearness of thought, he was required to work in accordance with a definite set of specifications covering the means whereby system, clearness, and accuracy may be attained. He was taught to recognize the importance of each step in the solution, as a link in the chain leading to a final result, and to surround his computations with as many safeguards and checks as necessity and time permitted. The result of this training in the mechanical side of analysis, was to increase tremendously the accuracy of the work. The student found himself not only getting more definite results but he also developed the power to find and correct his own errors. All this tended to increase his pride in his work and to give him confidence in himself; while at the same time he was forming good habits of thought and work which could be transferred to his engineering practice later on. In short, the class-room work was made to approximate actual engineering experience as closely as possible.

The results obtained make it clear that a system of instruction designed along the lines sketched above, does decidedly awaken and hold the interest of the student in the live problems of the engineering world. It does increase the confidence with which the student tackles a problem and stimulates his self-reliance and initiative, and at the same time he shows greatly increased industry and speed of learning. This is further accentuated by the fact that no grading is done on study problem work. The student is left free to take chances in doing independent thinking. The grading for purposes of classification in sections is based entirely upon work done on drill problems. The student is given to understand, however, that the only grades which effect his final passing in the course are those determined in the last four or five weeks of work, when nothing but review problems are taken up. His desire to work for passing marks becomes secondary and is dwarfed by his desire to understand engineering theory in order that he can use it in his work. His career as an engineer has begun.

This method of teaching mechanics offers unusual opportunities for instructors to do original work, by bringing in new problems derived from their own experience, and by making improvements in the methods of presentation and instruction. During the course at The Engineer School the class-room instructors suggested and worked out several study problems of great value and they also discovered certain new applications of theory which greatly amplified the work in some parts of the subject, and extended the usefulness of certain laws. The following officers were class-room instructors and to them is due great credit for the success of the course; Majors O. O. Kuentz and H. W. Sibert, and Captains L. Graham, W. E. Duckering, W. A. Lyon, E. R. Hyde and G. M. Steese.

THE COAST ARTILLERY AND THE RESERVE OFFICERS' TRAINING CORPS.

BY MAJOR HARRISON TILGHMAN,

Coast Artillery.

Mr. President and members of The Society for the Promotion of Engineering Education: Some several weeks ago, the society through its secretary, Dr. Bishop, kindly extended me an invitation to attend this convention.

I had hoped that I might come to listen rather than to talk. However, Dr. Bishop also invited me to take part in the discussion and while I feel some hesitancy in addressing so distinguished a gathering, I hope that as a worker in the mutual field my temerity will be pardoned.

Colonel Morrow has already discussed in most interesting fashion the subject of "Military Training in Engineering Schools," and while my own subject, "The Coast Artillery and the Reserve Officers' Training Corps," is more restricted, I feel that I must touch, to some extent at least, on the more general subject of the Reserve Officers' Training Corps, its reasons for being, and the results expected from it.

There are many theories of government, each of which when in control of a nation, determines its military policy. But one policy makes for security in peace and success in war: it is that one which will provide superiority in the theater of operations. The War Department is confronted with the necessity of making preparations for war with such means as the government will supply.

As between men, so between nations: good will is the best of assets, but potential strength receives deference during the course of argument, and superior strength gains the final decision.

At the time of the establishment of our country, the Americans were a small but homogeneous people accustomed to self-government and individual liberty. So jealous were they of these rights that the country itself was born in resistance to encroachment upon them. It is needless to add that it was force and not persuasion which accomplished the happy outcome. It is for us to preserve these rights. To do so we must be prepared to use the same means as were successful in their establishment.

In establishing our government our forefathers wisely decided upon a republican form. Now an intelligent electorate is the necessary foundation of a republic, for in a republic. the policy of the government flows directly from the ability of the average elector to pass judgment upon the issue. Therefore the preservation and future progress of our country is more completely determined by the education of its youth than by any other factor. It is in the hands of men such as those composing this society that the future of the country primarily rests.

But one may ask, How does all this concern the Reserve Officers' Training Corps? I answer: In two ways. First, those who would preserve their liberties must know them; and second, they must be able to protect them.

The R. O. T. C. exists to produce a citizenry of this character and for no other purpose.

Although there are many brilliant examples of success in the absence of a collegiate education, in general the college man is undoubtedly the leader in all lines and will become more and more so as the field of the pioneer in industry becomes circumscribed, and the general standard of education rises. We must look to the colleges for our leaders in both peace and war.

Recently we have beheld the spectacle of this country engaged, in spite of its own great forbearance, in war against an aggressive enemy. Fortune favored us in that we were able to prepare for the encounter behind the shield of the Allies. But so unprepared were we when we entered the fight that more than a year elapsed before we became an active participant. Those who believed and preached that a million men would spring to the defense of the country overnight had their dream rudely shattered. There was neither the arms to spring to, nor had the men been trained to do the springing. Military service is like any other endeavor. Training must precede performance. And while we trained, it is no secret, that grave apprehension was felt than an adverse decision might be reached in Europe before our forces became available. Those who were in France during the spring of 1918 know this but too well.

Many men strange to the uniform in April, 1917, made brilliant records as officers during the course of the war, bringing honor to themselves, the army, and their country. But they owe the opportunity to receive the necessary training to the strong wall of the Allies.

Friendships are relatively as valuable to nations as they are to men. Our country has recently made many and we hope will by all means permanently preserve them. But neither nations nor men can trade upon, and preserve friendships.

Time is of the essence in war, and a successful military policy cannot be based upon tardy preparation. America should always be ready to prevent war by readiness for it and in any alliance or league to do her full share from the first.

The Reserve Officers' Training Corps is a great and very necessary step in this direction. It is a fitting thing that, while preparing for his life's work, a student should also be learning his rights, and how to perform his duties as a citizen. Not the least of his duties is the protection of his country. The Reserve Officers' Training Corps will train the student so that upon graduation, he will stand ready to take his place as a junior officer in the army, and take it immediately.

Yesterday Dr. Goodnow spoke of the necessity of an education which will allow its possessors to evaluate correctly—perhaps no one is really educated whose training has not taken that form—let his specialized knowledge be what it will.

Let us evaluate correctly. I was much interested in the fourth resolution presented to the society by the special committee; which after rejecting a reference to courses which will develop effective citizenship, was finally adapted in the form:

"That engineering students be required to pursue courses which will develop their business and administrative qualities." While the rejection of reference to effective citizenship was based on the ground that present courses do make for effective citizenship; has not the society placed itself on record as holding that while something is now lacking in the business and administrative qualities of the graduate, nothing is lacking in his effective citizenship? It seems to me that this flows directly from the action, and that the view is false.

To quote from the report of the special committee "We are apt to oppose a new pedagogic proposition because we feel it will not work well under our own particular conditions." Might it not be also that lack of familiarity with just what is proposed may cause opposition?

The R. O. T. C. movement proposes to train a student in the full duties of citizenship, with a minimum of interference with his life's work. To do this the unit will be adapted to the institution rather than the institution to the unit.

I now find myself in somewhat of a quandary for the proposition which will be placed before educational institutions by the War Department has not been definitely established. In general, it is proposed to so place R. O. T. C. units that not more than two branches of the service will be represented in any institution, and so that there will be a proper military distribution of the 50,000 reserve officers which it is proposed to raise.

Within these limitations, the type of unit placed in an institution will be that which the institution is best fitted to receive. It is further proposed to give a basic course in military training during the first year and work of increasing specialization during the following years. All of these provisions are undoubtedly sound.

The Coast Artillery is that branch of the military service which man the guns (both rifles and mortars of large caliber) and submarine mines of our harbor defenses. It also mans the larger guns, both tractor drawn and railway mounted, which accompany an army in the field. Several other specialties, including the trench mortar and anti-aircraft armament, are manned by Coast Artillery troops.

Probably the Railway Artillery Reserve, American Expeditionary Forces, first commanded in action by Brigadier General F. W. Coe, now Major General and Chief of Coast Artillery; and afterwards until the close of the war by Brigadier General William Chamberlaine, now Commanding General, Coast Artillery Training Center, Fort Monroe, Virginia, had the most extensive service at the front of any of our artillery commands. Its guns were first in action during the winter of 1917–18 and thereafter continuously until the armistice. They were in position from Alsace to the British front and served with both the American and French armies. All units of the Railway Artillery Reserve, excepting a Naval contingent which joined in the summer of 1918, were drawn from the Coast Artillery Corps.

The Coast Artillery officer requires the general culture demanded by all arms of the service. He must also be an engineer, skilled primarily in the principles of civil, and also in those of mechanical and electrical engineering. Therefore, the engineering student most closely conforms to the requirements for a Coast Artillery officer and Coast Artillery instruction is best given in engineering institutions.

With this fact in mind, the Chief of Coast Artillery has already approved of the establishment of twenty Coast Artillery R. O. T. C. units. The lists will be later extended. Units of other branches of the service may or may not exist concurrently with a Coast Artillery unit.

At least one Coast Artillery officer will be assigned to each Coast Artillery unit. He will be supported by the necessary commissioned and enlisted assistants, and if he is the senior army officer present at the institution, he will be designated as the Professor of Military Science and Tactics. It is expected that he will be in every sense a member of the faculty.

A course of instruction has been designed for the Coast Artillery R O. T. C. student so that there may be no interference with his regular curriculum.

Problems, conforming to standard artillery practice, have been prepared for use in conjunction with standard collegiate courses, (such as those in physics, electricity, and mathematics) to make clear the application of the several subjects to Coast Artillery. These problems can be easily used by instructors and classes not familiar with military matters.

The scheme proposed included but one specialized course, that in gunnery. This will be required during two college years but will occupy but few term hours. However, gunnery itself is but a study of the movement of projectiles and of the theory of errors. It is therefore but a specialized study of certain laws of mechanics in conjunction with the law of probability. A thorough understanding of the latter is so necessary to an understanding of many engineering problems that an engineering student should welcome any instruction in it, supplemental to that which he will normally receive.

Engineering courses in general contain a sufficient course in surveying to meet the needs of the Coast Artillery. If in a particular instance this is not the case, the officer in charge of the Coast Artillery unit will be prepared to teach Orientation to such students as may require it.

The other subjects, which the Chief of Coast Artillery holds as prerequisite to a reserve commission, are all of a general cultural character; mathematics, through trigonometry, physics, history, government, English, and the rudiments of one foreign language. Some of these subjects are university entrance requirements and no engineering school would confer a degree upon a candidate less versed in them than the Coast Artillery standard requires.

Two summer camps, each of six weeks duration must be attended by the student. These will be periods of intensive military training. At them, the student will become familiar with the army and its methods, take part in and command military formations, and fire the guns, both artillery and small arms, of which he has studied, and which he will man in case of war.

The law provides certain allowances for R. O. T. C. students. In order that he may receive these, the student must pursue studies of a distinctly military value at a prescribed rate, never in excess of five hours per week. The Chief of Coast Artillery realizes that the subjects which he considers essential are by no means the only subjects of distinctly military value and has approved a list of many other subjects of this character. If the student is not pursuing the required subjects at the rate prescribed by law, courses in the additional subjects will meet the time requirement. Doubtless every engineering student will always more than meet the legal time requirement by studies ordinarily taken in the course. It is desired that his studies from the list of optional subject be as extensive as possible, for each will greatly increase his value to the service. According to the original scheme, now subject to modification, drill is not required during the college year. However, physical training is insisted upon. The student must either engage in college athletics or take other exercises to insure his physical development. The Coast Artillery officer at the institution will give every assistance in this matter and will conduct exercises at the request of the faculty, but ordinarily the direction of this work will be under the institution's own physical director.

The first of the summer camps for the Coast Artillery R. O. T. C. will open at Fort Monroe, Virginia, on the twenty-eighth of June and will be attended by students from units already established.

The schedule will be strenuous but interesting, and in addition to work, necessarily of a routine character, it will include a number of lectures by specialists in their subjects and visits to points and things of interest to the military student.

The results of the entire movement will be twofold; first, better citizens in peace, available as officers in the event of war; and second, added prestige and strength to the nation.

I would leave with you thoughts, first that of George Washington who said: "To be prepared for war is one of the most effectual means of preserving peace. A free people ought to be not only armed but disciplined." And finally that of Mazzani, triumvir of Rome, and the spiritual force of the Italian resurrection: "Without national education there exists morally no nation. The national conscience can not be awakened except by its aid. Without national education common to all citizens, the equality of civic duties and rights is an empty formula."

THE SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION. A SURVEY OF ITS PAST AND A RECONNAISSANCE OF ITS FUTURE.

BY GEORGE R. CHATBURN,

Past-President, Professor of Applied Mechanics and Mechanical Design,
University of Nebraska.

A quarter of a century ago an impetus was given to engineering and the industrial arts by the great Columbian Exhibition held at Chicago. Then the new world, like a fledgling, spread its wings for independent flight, and surprised itself with a showing of strength which until then no one thought it possessed. By a vigorous exercise of the indomitable "I will" which has come to characterize the great inter-oceanic city, and with the unstinted, almost prodigal, aid of every part of this vast nation, the products of the genius of man and the bounties of nature were collected and exhibited to thousands who in turn told of them to other thousands until our whole people saw and believed in their own strength. They then knew, as they before had merely thought, that this country was not only great in natural resources, but also great in achievements. They saw, too, that with the vast resources so generously supplied by nature much greater achievements might be accomplished. The past was but an inspiration for the future. The present mammoth industries were beginning their era of expansion; electricity had just started in earnest its world conquering course, and many of its greatest progeny had not yet been born; the automobile was but a frail infant; the horseless carriage was so great a novelty that the few sporadic designs drew crowds when they appeared on the street and were written up by the press under such lurid headlines as "The Red Devil Makes Another Appearance"; Chanute and

Langley were making experiments in aëronautics, but it was many years later before extended flight could be sustained in the atmosphere; even the telephone though in use was not a household necessity as at present, while wireless telegraphy and telephony were unknown and unthought. Thus might be continued a description of the condition of engineering a quarter of a century ago; of engineering industries which have since made places in the commercial world for a large moiety of our people, places that were sadly needed, for, prior to that time most of our great railroads had already been laid and the land opened up by them was largely appropriated.

The great exhibition to which reference has been made, and which encouraged and accelerated the almost miraculous industrial evolution following it, planned numerous congresses on varying subjects; among others a Congress of Engineers. The committee in charge of this congress had for its chairman the late E. L. Corthell and for its vice-chairman the late Octave Chanute, both afterwards members of this Society. Mr. Corthell being unavoidably absent, the honor of presiding over the congress fell to Mr. Chanute. For convenience and the congenial grouping or allied subjects the congress was separated into divisions: A, Civil Engineering; B, Mechanical Engineering; C, Mining Engineering; D, Metallurgical Engineering; E, Engineering Education; F, Military Engineering; and G, Marine and Naval Engineering. Of Division E, Engineering Education, Professor Ira O. Baker, to whom is given the credit of suggesting the division, was chairman. The first session of the general congress was scheduled for 10 o'clock and the first session of the division for 11:30 o'clock, Monday, July 31, 1893. Meetings were also scheduled for Tuesday, Wednesday, Thursday and Friday, following. The papers covered a wide range and discussed "the present state of collegiate engineering education" and also the "ideal engineering education." "Favorable and unfavorable tendencies in engineering education" received attention, and there was a "comparison between American and European methods of engineering education."

Some of the questions propounded have not yet been settled: the "maximum and minimum mathematics necessary to the engineer" is a subject frequently touched upon in present-day periodicals as well as the "training of students in technical literary work."

In reading Volume I of the *Proceedings*, one is struck with the breadth and intensity of the papers presented in this first meeting, with the vision and prescience of their authors and with the solidarity and practicality of their ideas. Who can find fault with this statement? ". . . it is a safe assumption that even the ideal engineering education cannot be expected to produce young engineers so mature in the exercise of all their professional functions that nothing is left for the years of subsequent practice to accomplish in the direction of education."* Or this. ". . . it is the whole essence of modern engineering practice so to control and adopt the laws and quantitative deductions of the ideal conditions of engineering physics as to make them fit with reasonable accuracy its very varying and complicated conditions."† Another writer believes ". . . that the attempt sometimes made so to educate a young man that he will step from school a practical engineer is abortive."‡ This idea that an engineering school does not graduate engineers but men who are better fitted by virtue of their education to become engineers, recurs again and again in the twenty-five volumes of the PROCEEDINGS. The generally believed dictum that college graduates are impractical, illustrated by the story of the technical graduate who was told early one morning "to order sent one hundred feet of chain capable of carrying ten tons," and who later in the day when asked if he had ordered the chain replied, 'No, I have been figuring it out,' showing his several pages of foolscap covered with figures as proof, when a reference to a handbook or a wise selection of a practical method would have given him the size in half a minute,'' caused many instructors and schools *to go to the other extreme.*[*] So that numerous writers thought it necessary to warn instructors of the danger of an ''over-practical'' education. Training in the fundamental theoretical principles is frequently advocated. One man fears ''too much time may be given to hand work and not enough to head work.''[†]

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* "The Ideal Engineering Education," by Wm. H. Burr, *Proceedings*, Vol. 1.

† *Ibid.*

‡ "Favorable and Unfavorable Tendencies in Engineering Education," by Palmer C. Rickets, *Proceedings*, Vol. 1.

This contest between the theoretical and practical in engineering education continues throughout the history of the Society and we have not yet seen the last of it.

Three years before the Columbian Exposition Prof. S. W. Robinson of The Ohio State University ''organized an association composed of mechanical engineering teachers.''[‡] On Tuesday, August 1, 1893, the second day of the Columbian Exposition Congress of Engineers, ''Prof. S. W. Robinson, president of the Association of Teachers of Mechanical Engineering explained the object and organization of that society and invited those interested in engineering to meet his society at 9 a. m. Wednesday morning to consider methods of organization of the engineering teachers.''[§] This seems to be the first recorded suggestion for the formation of a society of engineering teachers. In the obituary of Prof. Robinson, it is stated that ''his interest in education was always great and led him in 1890 to organize an association composed of mechanical engineering teachers which in 1893 developed into the present Society for the Promotion of Engineering Education.''[‖]

Professor Baker has frequently been spoken of as the father of the Society for the Promotion of Engineering Education. In fact,* it was he who first suggested the desirability of arranging for a meeting of engineering teachers. The president of the congress auxiliary "thought the proposed meeting should be held in connection with the Education Congress; but Professor Baker's views prevailed, and meetings on Engineering Education were arranged as Division E of the Engineering Congress." And further, "on the nomination of Professor Baker, the World's Congress Auxiliary appointed a special committee to arrange for the meetings of Division E; but the entire work of arranging the program and working out the details of the meeting fell to Professor Baker." A statement is also made that "the feeling was general that a permanent organization of the engineering teachers should be established; and in response to a vote to that effect, the chairman appointed a committee to formulate plans for such an organization. Later the committee presented a constitution which was adopted and which has continued substantially unchanged as the fundamental law of the Society for the Promotion of Engineering Education."†

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[*] See discussion by Prof. John Goodman, Yorkshire College, England, p. 102, Vol. 1, *Proceedings.*

[†] Palmer C. Rickets, Vol. 1, *Proceedings.*

[‡] *Proceedings,* Vol. XIX, p. 511.

[§] *Proceedings,* Vol. 1, p. 8.

[‖] *Proceedings,* Vol. XIX, p. 511.

But unfortunately for the statement the records of Division E, as printed in the PROCEEDINGS, do not show the appointment of such a committee either before or after Professor Robinson gave his invitation. In the minutes for Friday, the fifth day of the meeting, we read, it was "voted that the publication of the papers presented before this division of the Congress be left in the hands of the divisional committee of the Congress auxiliary with power to turn them over for publication to an organization of engineering education if such is effected." This minute occurs after the record of the reading of a paper by Professor Lanza in the discussion of which Professor Johnson said "that this paper offered one of the best evidences they could have of the necessity for and benefit likely to come from an organization of teachers such as *had*

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* Index to Vol. I–XX, "Origin of the Society," p. 3.

† Index Volume, p. 3.

been effected that morning.'' At this same session on which it had been voted to turn over the papers to an organization ''*if one is effected,''* and in which Professor Johnson speaks of one having been ''*effected that morning,''* Chairman Baker ''took pleasure in knowing that this meeting had been the occasion of the *organization of an Association of Engineering Teachers.''* On the following day, the sixth of the Congress, Mr. C. Frank Allen, secretary of Division E, made formal report for that division in which he stated ''that a society had been *organized by the members of that division* for the promotion of engineering education.'' The history seems clear this far:

Professor Ira O. Baker suggested a meeting of engineering teachers as a division of the Congress of Engineering and prepared the program. As a result of this meeting the Society for the Promotion of Engineering Education was formally organized on the forenoon of Friday, August 4, 1893.

It is not clear from the record that Professor Robinson's invitation, given on Tuesday, August 1, to meet with the Engineering Teachers' Association Wednesday, August 2, had no influence whatever upon the formation of this organization; however, the statement made in the index volume* that ''in no sense is this society the outgrowth or the successor of that organization,'' is very probably correct.

We are told there were about 70 at the meetings of the Division and that 63 of them became members of the new Society. Others were doubtless registered during the year, for Vol. II of the *Proceedings* gives the names of 70 persons with the year 1893 as the date of membership. Considering these 70 as the charter roll, there are according to the 1918 Year Book 35 of them still members of the Society, and 14 more remained members until death overtook them. This is a remarkable percentage after twenty-five full years have elapsed and shows in itself the worth and character of the Society to its members.

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* Index Volume I–XX, p. 4.

GROWTH OF MEMBERSHIP.

You are all familiar with the history of the growth in membership. The yearbooks for some time have contained a schedule showing that growth. It is not probable that it may continue indefinitely, for a large percentage of all engineering instructors in the United States are already members. So that from now on we can only expect to maintain a membership about as large as at present, with possibly a slow rate of increase as the engineering instructors in the schools increase, and practitioners take sufficient interest to maintain memberships. The table and graph of membership, distributed into the geographical divisions used by the United States Commissioner of Education, shows the membership of the North Atlantic and the North Central Divisions to have remained remarkably equal until the last three years when the North Central has fallen off somewhat. The South Atlantic and South Central remained practically equal, increasing slightly during the last half of the quarter-century. The Western Division shows a slow increase. In percentages the North Atlantic Division remained practically constant at about two fifths of the membership. The North Central Division, starting at one third, got up to 42 per cent., but has dropped back to the original basis. The Southern and Western Divisions show increases in percentage in later years.

CENTER OF MEMBERSHIP.

The center of membership of those within the United States exclusive of detached possessions is approximately on the state line between Ohio and Indiana, just a little south of the city of Decatur, Indiana, that is, about 140 miles northeast of the center of population of the United States, which the Census Bureau places at Bloomington, Indiana. In 1893, the center of membership was about forty miles north of Columbus, Ohio. It moved northwest and then southwest to its present location. (Fig. 8b.) If the center of membership ought to agree with the center of population, the inference

TABLE I.

Membership—Distributed by Occupation.

	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	1905.	1906.	1907.	1908.	1909.	1910.	1911.	1912.	1913.	1914.	1915.	1916.	1917.	1918.
Administrative—College....	3	14	18	21	21	22	31	30	32	33	30	43	50	27	26	44	51	58	99		....	136	....	167	....	145
Industrial	1	3			2	3	5	6	9	11	18	14	15		1	1		9			....	63	....	101	....	90
Architecture		1		1	2	2	3	2	5	5	4	5	5	4	3	4	5	7	8	12	16	14	19	16	....	14
Agriculturing Engineering ..																				3	8	9	12	11	....	10
Chemistry		2	2	2	3	3	4	2	4	4	4	5	5	5	10	14	11	21	16	23	....	22	....	22	....	23
Civil Engineering	26	57	66	68	67	72	66	66	64	72	74	79	82	104	136	166	182	239	246	....	....	270	....	290	....	318
Electrical Engineering......	1	4	6	12	17	20	25	22	23	24	35	41	41	47	60	87	96	107	139	160	215	176	238	220	....	230
Geology and Metallurgy....				2	3	3	5	5	5	3	3	6	7	5	6					10	23	10	....	12	....	13
Industrial Engineering																				....	....	....	24	....	....	4
Language.................					2	2	1	1												7	8	10	12	14	....	16
Machine Design and Drawing	3	3	3	7	7	8	15	8	11	16	19	24	22	16	16	27	42	44	56	65	98	71	117	66	....	67
Mathematics..............		4	7	7	13	12	15	16	18	21	22	25	27	37	40	57	64	78	77	96	91	100	111	92	....	86
Mechanical Engineering	18	37	38	38	39	42	43	41	43	44	52	56	63	69	99	141	144	176	172	141	....	163	206	217	....	215
Mechanics and Materials ...	9	11	14	14	18	15	18	17	13	10	13	14	15	13	15	23	25	41	41	52	73	64	85	59	....	59
Mining Engineering........	1	5	5	5	5	5	3	3	4	4	6	7	9	14	14	26	32	28	31	17	21	17	....	22	....	24
Physics..................		2	6	6	8	10	9	10	5	6	11	11	12	13	24	36	38	47	47	59	60	59	....	52	....	57
Sanitary Engineering.......						1	2	2	2	3	3	3	4	4						....	....	6	30	20	....	23
Shop and Mechanic Arts....	1	1	3	2	2	2	5	4	8	6	8	9	7	11	14	16	10	17	16	27	50	43	....	38	....	32
Miscellaneous	7	12	20	18	17	22	16	16	15	16	22	36	36	27	34	41	49	65	27	....	....	58	....	28	....	15
Total	70	156	188	203	226	244	266	251	261	278	326	379	400	415	503	687	747	938	1,010	1,166	1,291	1,381	1,403	1,447	1,447	1,440
Institutional Members......																					45	48	49	55	58	66
Total Enrollment	70	156	188	203	226	244	266	261	261	278	326	379	400	415	503	687	747	938	1,040	1,166	1,336	1,429	1,452	1,502	1,505	1,506

Colleges and Universities Teaching Engineering Represented in the Membership List.

	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	1905.	1906.	1907.	1908.	1909.	1910.	1911.	1912.	1913.	1914.	1915.	1916.	1917.	1918.
Domestic	32	69	...	...	...	...	...	...	...	68	76	90	89	85	94	116	126	121	137	135	140	145	151	158	....	159
Foreign	10	10	...	...	...	...	...	...	...	5	5	6	7	6	5	5	9	12	12	14	16	18	18	20	....	22
Man. Train., High, Cor. and Trade	42	3	...	...	...	...	...	...	...	9	12	10	10	13	17	19	9	13	16	18	25	25	25	21	....	32
Total	42	82	...	...	...	...	...	...	...	82	93	106	106	101	116	140	144	146	165	167	181	188	194	202	218	213

Attendance at the Annual Meetings.

	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	1905.	1906.	1907.	1908.	1909.	1910.	1911.	1912.	1913.	1914.	1915.	1916.	1917.	1918.
Members	*	*	*	39	*	69	*	45	44	57	47	52	43	42	75	103	103	151	115	191	114	171	177	122	156	
Officially Recognized Guests	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	13	*	*	21	3	17	33	25	9	
Total	...	...	...	39	...	69	...	45	44	57	47	52	43	42	75	103	116	151	115	215	117	188	144	147	165	

* Not reported.

TABLE II.

Geographical Distribution of Members—Regional Divisions.

	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	1905.	1906.	1907.	1908.	1909.	1910.	1911.	1912.	1913.	1914.	1915.	1916.	1917.	1918.
North Atlantic Division	28	65	76	77	83	95	93	99	106	116	131	152	151	160	189	269	308	381	427	492	539	562		566	569	566
North Central Division	24	51	66	81	90	90	102	110	104	103	127	144	161	163	213	270	287	358	380	397	428	466		494	479	450
South Atlantic Division	3	9	12	10	11	11	8	7	8	14	19	19	19	18	21	25	30	41	45	51	65	74		89	91	111
South Central Division.....	2	11	13	14	19	22	22	24	21	21	24	27	31	32	34	42	47	57	55	65	76	81		86	89	89
Western Division..........	4	8	9	10	10	11	11	11	12	12	16	26	26	32	36	51	53	66	90	113	121	126		140	147	155
Foreign and Detached......	9	12	12	11	13	15	15	15	10	12	9	11	12	10	10	18	22	35	43	48	62	72		72	72	70
Totals...............	70	156	188	203	226	244	251	266	261	278	326	379	400	415	503	675	747	938	1,040	1,166	1,291	1,381	1,403	1,447	1,447	1.441
Institutional																						48	49	57	58	66
North Atlantic Division																										
Maine		1	2	2	5	7	6	6	6	3	3	3	2	1	1	3	3	4	6	9	9	8		8	9	10
New Hampshire.........	1	3	3	4	4	5	3	4	5	8	7	7	5	5	5	5	5	7	6	6	7	7		9	8	8
Vermont		2	2	2	2	2	2	2	1	3	4	5	4	4	4	6	6	5	6	7	8	10		9	9	11
Massachusetts	5	15	18	20	22	27	26	29	30	31	31	40	41	42	48	71	78	91	92	117	122	118		124	120	119
Rhode Island............		1		1	1	1	2	2	2	2	5	6	6	6	6	8	7	9	9	12	12	12		13	13	13
Connecticut		3	3	4	4	4	4	5	4	3	2	2	2	2	2	11	14	16	14	23	24	26		24	26	25
New York	12	20	25	24	24	29	31	29	32	38	46	52	53	59	70	91	100	136	160	158	175	170		167	163	168
New Jersey	4	6	5	4	4	4	4	4	4	4	6	7	6	8	12	20	29	28	33	34	36	39		40	42	44
Pennsylvania	6	14	18	16	17	16	15	18	22	24	27	32	32	33	41	54	66	85	101	126	146	172		172	179	168
North Central Division																										
Ohio	3	5	6	8	10	11	18	20	18	14	18	20	21	23	43	52	53	58	59	61	74	85		84	82	87
Indiana	4	9	13	11	13	13	14	15	15	14	15	19	18	15	21	22	23	26	21	26	29	27		33	32	27
Illinois	4	6	7	11	12	13	14	15	14	16	21	26	29	33	44	52	57	77	89	94	95	95		102	100	87
Michigan	1	4	4	7	9	10	12	13	11	13	14	14	22	20	26	36	34	39	46	45	47	49		53	50	46
Wisconsin	5	7	7	7	8	8	9	8	9	9	11	13	17	16	18	22	27	32	33	35	31	36		33	32	32
Minnesota	2	3	8	14	15	14	11	12	12	11	13	14	13	14	14	20	20	24	29	31	35	37		30	28	28
Iowa..................		2	3	4	4	4	6	7	7	7	10	8	11	13	14	15	16	22	25	26	31	35		42	39	36
Missouri...............	3	8	10	10	10	10	8	9	10	10	16	20	20	20	18	26	27	35	37	33	37	39		40	37	34
North Dakota...........		1	1	1	1	1									3	5	5	6	6	7	9	8		7	7	7
South Dakota...........		1	1	2	2	2	2	2	2	2	2	2	2	2	3	4	4	6	6	5	7	6		8	8	8
Nebraska..............		2	3	4	4	3	5	6	4	5	5	6	6	6	7	6	6	10	11	16	13	13		14	14	12
Kansas................	2	3	3	2	2	1	3	3	2	2	2	2	2	1	2	10	15	23	18	22	20	36		48	50	46

TABLE 11 (*Continued*).

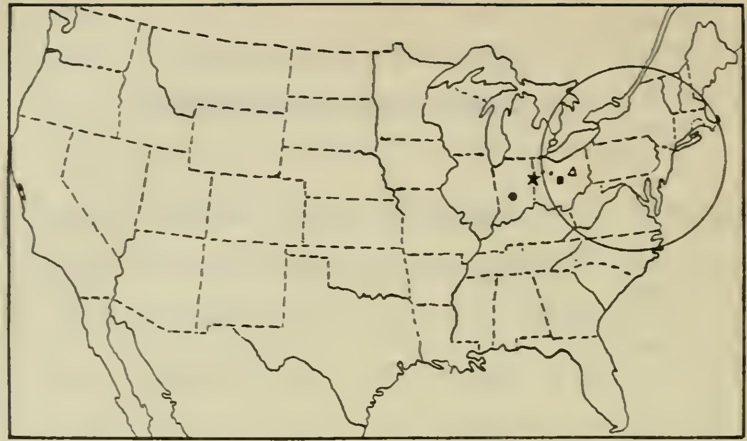
Geographical Distribution of Members—Regional Divisions.

	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	1905.	1906.	1907.	1908.	1909.	1910.	1911.	1912.	1913.	1914.	1915.	1916.	1917.	1918.
South Atlantic Division																										
Delaware	1	2	2	1	1	1	1	1	1	3	3	2	1	1	1	2	2	4	4	5	4	5		6	6	6
Maryland		2	2	2	2	2	1			2	3	3	2	2			1	1	5	5	7	9		9	10	15
District of Columbia		1	2	1	1	1			1	1	1	2	3	3	7	8	8	10	10	6	10	11		11	13	25
Virginia	1	2	2	2	2	2	2	2	2	3	4	3	2	2	2	4	4	6	8	10	11	14		22	22	21
West Virginia	1	1	2	3	3	3	2	2	2	2	2	2	3	3	4	4	5	8	5	7	7	8		9	9	10
North Carolina			1										1	2	1	2	5	7	5	7	9	10		14	12	13
South Carolina		1	1	1	2	2	2	2	2	3	3	3	3	3	2	2	2	2	2	6	8	7		7	8	6
Georgia											1	2	2	1	2	1	1		2	2	3	4		4	4	8
Florida											2	2	2	1	2	2	2	3	4	3	6	6		7	7	7
South Central Division																										
Kentucky		1	1	1	3	4	5	5	3	3	3	3	4	3	1	3	4	4	4	4	4	4		6	6	6
Tennessee	1	4	4	4	4	4	3	3	3	3	3	4	4	4	5	7	6	7	6	6	7	7		7	8	10
Alabama		2	3	4	6	6	6	6	4	3	4	4	6	7	8	9	9	12	12	12	15	14		15	15	11
Mississippi		1	1	1	1	1	1	2	1	1	2	2	2	2	3	3	4	5	5	5	9	8		10	10	8
Louisiana		2	2	3	3	4	3	3	4	4	5	4	4	3	6	6	6	7	7	8	9	10		10	10	10
Texas	1	1	2	1	2	2	3	4	5	6	6	7	7	9	8	9	10	13	14	18	16	21		24	27	25
Arkansas						1	1	1	1	1	1	3	4	4	3	4	5	6	6	4	7	7		5	5	5
Oklahoma																1	3	3	1	8	9	10		9	10	14
Western Division																										
Montana								1		1	2	3	3	3	2	2	2	3	4	6	6	7		7	6	7
Wyoming		1	1	1	1	1												1	3	4	4	3		5	6	7
Colorado		2	2	4	3	4	4	4	4	3	5	11	11	14	11	14	12	14	14	20	26	33		38	40	45
New Mexico							1	1	1							2	1	2	5	5	4	6		4	7	8
Arizona															2	2	1	1	1	1	2	2		4	4	4
Utah	1	1	1								1	1	1	1	3	6	6	6	12	11	10	9		8	8	6
Nevada					1	1	1	1	1	1	1	1	1	2	2	3	3	3	1	1	3	4		4	4	4
Idaho		1	1	1	1	1										3	2	4	7	8	8	5		4	3	6
Washington									1	1	1	4	4	4	8	8	12	14	15	21	20	21		22	22	20
Oregon																3	3	4	10	10	10	10		10	10	8
California	3	3	4	4	4	4	4	4	5	6	6	6	6	8	8	8	11	14	18	26	28	26		34	37	40

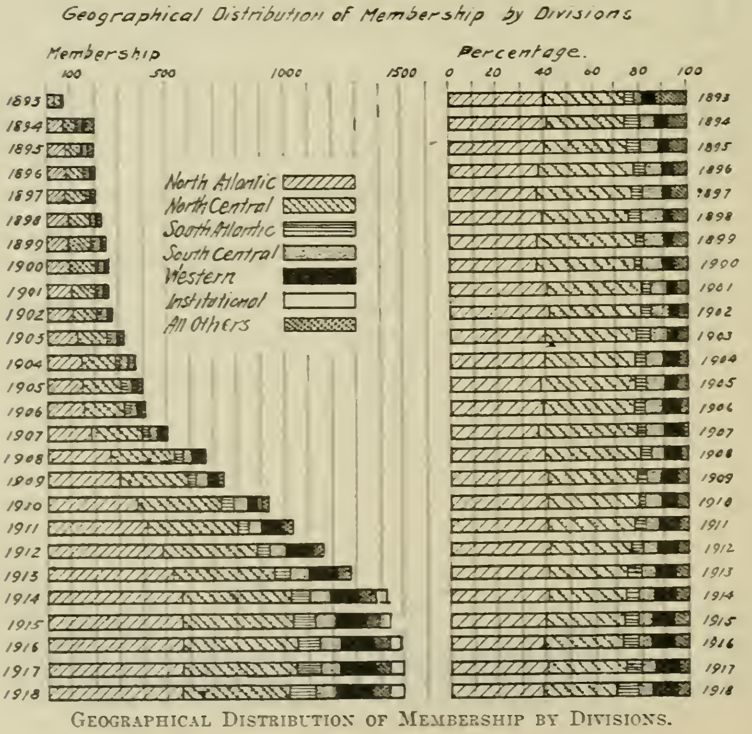
TABLE II (*Concluded*)

Geographical Distribution of Members—Regional Divisions.

	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	1905.	1906.	1907.	1908.	1909.	1910.	1911.	1912.	1913.	1914.	1915.	1916.	1917.	1918.
Foreign and Detached																										
Argentine									1																	
Australia								1	1	1	1	1	1	1	1	2	2	2	2	3	4	6		7	7	7
Belgium																				2	1	1		1	1	1
Brazil																	1	2	2		3	3		2	2	2
Canada	2	3	3	3	5	6	6	6	6	7	7	9	9	7	7	10	9	16	19	24	30	36		37	35	32
Chili																		1	2	3	3	3		3	3	4
China																	3	2	3	1	2	4		5	5	6
Cuba																					1	1				1
England	3	4	4	4	4	5	3	3	2	1	1	1	1	1	2	1	2	2	3	3	2	2		2	2	2
France			1	1	1	1	1	1																		
Germany			2	2	2	2	2	2								1					1					
Greece																					1	1		1	1	1
Hawaii																		2	1	1	1	2		1	2	1
Hungary																	1	1	1	1	1	1		1	1	1
India																		1	1	1	4	4		4	4	4
Italy																1	1									
Japan																		1	3	3	3	3		3	3	3
Mexico																1	1	1	1	1	1	1		1	1	1
Norway																						1		1	1	1
Panama																		1	2	2	2	1				
Philippine Islands																2	2	2	2	1						
Porto Rico																									1	1
Russia	1	1	1															1	1	1						
Switzerland	1	1	1	1	1	1	1	1					1	1												
Turkey																				1	2	2		3	3	2
Unknown								2	1		3															



The star indicates the location of the Center of Membership in 1918; the square dot in 1893; round dots other positions between. The triangle indicates the Median Point of Membership. Within the circle shown (350 miles radius) reside more than one half (53 per cent.) of the entire membership. The small circle ⊙ shows the center of population of the United States.



GEOGRAPHICAL DISTRIBUTION OF MEMBERSHIP BY DIVISIONS.

is that the schools of the West and South have not quite kept up with those of the East and North.

The meridian of 82° will approximately divide the membership equally; the parallel of 40½° will also approximately divide it equally. The median point of membership, therefore, lies approximately at the intersection of these two lines, which is near Mansfield, Ohio.

A circle with a radius of 350 miles having its center at Harrisburg, Pa., will enclose more than 53 per cent. of all the members.

PUBLICATIONS OF THE SOCIETY.

Twenty-five volumes of the *Proceedings* and one index volume have been issued. These, excluding the explanatory part at the beginning of each volume, contain 9420 pages.

TABLE III.

Number of Pages in the Proceedings of the Society for the Promotion of Engineering Education.

Vol.	I	8 + 342
	II	6 + 291
	III	20 + 402
	IV	22 + 362
	V	22 + 337
	VI	27 + 324
	VII	27 + 193
	VIII	28 + 377
	IX	28 + 348
	X	32 + 300
	XI	36 + 379
	XII	40 + 253
	XIII	40 + 324
	XIV	48 + 300
	XV	57 + 690
	XVI	70 + 414
	XVII	72 + 244
	XVIII	16 + 457
	XIX	20 + 522
	XX Part I	1 + 226
	XX Part II	22 + 508

XXI	25	+	450
XXII	33	+	374
XXIII	26	+	423
XXIV	20	+	346
XXV	18	+	250
Index (I–XX)	—		84
			9,420

In June, 1910, the council ordered the publication of the Bulletin as an experiment. This proved so popular that the dues were raised the next year to four dollars, one of which was applied as a subscription to the Bulletin. In 1916 the name of the Bulletin was changed to "Engineering Education." Formerly the membership list, geographical distribution, statistics of membership, and other information was published as part of the proceedings. This has proven extremely valuable to one who is looking up the history of the organization. But the matter grew until over 70 pages were required. So a separate book, which is in reality one number of the Bulletin, is now devoted to this information, and requires about 100 pages.

The Bulletin or rather the periodical, "Engineering Education," has now offered to it more papers than it can find room for. This in itself is an excellent thing for only the best need be published. And authors seeing their work in "Engineering Education" may know that it has passed the careful scrutiny of the publication committee and by them been termed good.

The Secretary's Office.

The work of this office, heavy from the beginning, became more and more extensive until there came a demand for a permanent paid secretary. At the Minneapolis meeting in 1913, the Council recommended "that the Society take steps necessary to render the Secretaryship permanent"; and also "that the retiring and incoming presidents and the treasurer be appointed a committee to consider and report . . . as to whether the Secretary of the Society should necessarily be in the active work of teaching, and second to find a suitable man who will accept the position of permanent Secretary of the Society beginning in 1914.'' Nothing seems to have been done with this. Possibly the Society thought that as long as it could secure efficient secretaries from its own membership there is no need for other action. It appears from the expense accounts that the first honorarium received by the Secretary was reported in the proceedings of 1901; the amount $50. In 1905, it had raised to $100; in 1908, $250; in 1911, $400, together with an allowance for editing the BULLETIN of $350; in 1913, the budget shows an honorarium for $1,000; in 1916, there was added an honorarium for an assistant Secretary of $600. Clerical assistance was likewise allowed.

The work of the office has grown faster than the increase in membership. At first the Secretary had to look after the annual meeting and the printing of the *Proceedings;* now, there is in addition to this, which, in itself, has increased 2,000 per cent., the preparation and editing of the BULLETIN and much of the financial business pertaining thereto to look after.

THE TREASURER'S OFFICE.

The present Treasurer, Mr. W. O. Wiley, has thoroughly systematized the work of that office. His report (1914 *Proceedings*) states that the accounts are kept according to the following schedules which are on file for reference by members at this office: ''(*A*) Back dues, (*B*) Current dues, (*C*) Accounts receivable for advertising and publications from members and non-members, (*D*) Members paid in advance, (*E*) Due non-members, (*F*) Printing (sundry, BULLETIN, *Proceedings* and reprints), drawing and engraving and editor's salary, (*G*) Inventory of *Proceedings*, BULLETIN and reprints, (*H* and *I*) Expenses of meetings, (*J*) General expenses, such as postage of all kinds, telegrams, advertising of publications, expressage and freight, clerical assistance, insurance, committee expenses, Secretary's salary, etc., (*K*) Expenses of the Treasurer's office." The expense to the Society of the office is now approximately $300 per year.

CLASSIFICATION OF PUBLISHED PAPERS.

Dean Fletcher in his presidential address in 1903 classified the papers and committee reports in the first nine volumes of the *Proceedings* into two major and several minor classes according to the following schedule:

A. Those treating of general topics, affecting our policy in the large.
  1. Engineering education in the ideal, general policy, education vs. culture, electives, etc.
  2. Instruction in general, management research, theses, etc.
  3. Equipment as to general features. (School Architecture.)
  4. Graduation and degrees.
  5. Historical, comparative tendencies, etc.
  (6. Miscellaneous.)

B. Those relating to details and special methods, qualifications, etc.
  1. Papers and reports relating to teaching in special departments, methods and details.
  2. Those relating to apparatus and equipment for specific purposes.
  3. Those relating to preparatory studies, conditions, of admissions and auxiliary branches.
  (4. Miscellaneous.)*

For comparison the writer has tried to follow out this classification with 24 volumes, using Dean Fletcher's work for the first nine volumes.

The results are given in tabular form. They show remarkable similarity considering the fact that different persons made the classifications and that very frequently it was difficult to say in which of two classes a paper should be classified.

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* Items in parentheses have been added by the writer.

In late years there seems to have been a tendency from the more general subjects *A* to the more specialized subjects *B*.

TABLE IV.

Classification of Published Papers.

Class.	Sub-class.	Number of Papers.		Percentage of Whole.			
		9 Volumes.	24 Volumes.	9 Volumes.		24 Volumes.	
A	1	31	79	16	47	13	53
	2	20	129	11		21	
	3	5	25	3		4	
	4	8	20	4		3	
	5	18	42	10		7	
	6	5	31	3		5	
B	1	59	222	31	53	36	47
	2	14	26	7		4	
	3	24	29	13		5	
	4	3	9	2		2	
Total ..		187	612	100		100	

A was largely increased during the last few years because of so many papers relating to management and efficiency. *B* was large during the early history of the society because "entrance requirements" was then a very popular subject.

ENTRANCE REQUIREMENTS.

During the first few years of the existence of the Society considerable effort was made to standardize the entrance requirements of engineering colleges. A committee with Professor Tyler, of Massachusetts Institute of Technology as chairman, worked for several years on the subject and presented a final report in 1901. During this same period other organizations were engaged along the same lines; especially may be mentioned the work of the National Educational Association. The National Educational Association proposed a scheme of points or weighted subjects which appeared so simple that practically all the first-class colleges in the country have adopted it. To say, however, that because the N. E. A. plan was the one finally adopted, the work of this association was non-effective, would not be a fact, for engineering schools up to 1893 had maintained, almost uniformly, lower entrance requirements than the academic colleges.

Rensselaer offered its first engineering course in 1835, graduating its first engineers in 1840. A prepared notice,* dated October 14, 1835, states the requirements thus:

> "Candidates are admitted to the Institute who have a good knowledge of arithmetic and can understand good authors readily, and can compose with considerable facility."

The Lawrence Scientific School, which was the third engineering school (not counting West Point and one or two private military schools) to offer work in engineering, in 1848 had these requirements, they being much lower than for other departments of Harvard College:†

> "Candidates for admission must have attained the age of 18 years, must have received a good common English education, and must be qualified to pursue to advantage the courses of study to which they propose to give their attention."

It might be interesting to follow the history of engineering-school entrance requirements, but time will not permit. However, by 1865, when the Massachusetts Institute of Technology was founded ,they had advanced very materially. Some complaint was offered to the low requirements of the M. I. T. compared with the Rensselaer which had developed wonderfully and was considered to be at this time the leading engineering school of the country. And probably had it not been for the peculiar genius of William B. Rogers the M. I. T. would have remained an inferior school and never have reached the standing it soon attained.

It was largely because of the lower entrance requirements and the consequently lower standing of the graduates that engineering schools were considered inferior to the classical colleges. Consequently the S. P. E. E. at its very inception did a wise thing to discuss so carefully the question of entrance requirements. This discussion and the reports submitted no doubt assisted in molding opinion and establishing the higher grade of entrance requirements for engineering schools. The higher entrance requirements made it possible to adopt a curriculum of substantial studies and thus in every particular to place the engineering college on a par with the academic.

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* Photographic reproduction in *Eng. News* of April 21, 1892.

† *Engineering News*, May 19, 1892, p. 514

THE COURSE OF STUDY.

The earliest engineering schools did not pretend to be colleges in the sense of the traditional institutions. Rensselaer in the same notice previously quoted from states:

> One year is sufficient for obtaining the Rensselaer degree of Bachelor of Natural Science, or of Civil Engineer, for a candidate who is well prepared to enter. Graduates of colleges may succeed by close application during the twenty-four weeks in the summer term.
>
> The degree of Master of Arts is conferred after two years of practical application.

Some of our older men have recently in the periodicals extolled the old time education as more thorough than the present. Evidently, they are looking backward through the telescope of age, for certainly no one will contend that a modern engineer can be trained in 24 weeks. Nevertheless, it might be interesting to see what the student was expected to get in this year of study:

> Students in the engineering corps are instructed as follows:
>
> Eight weeks, in learning the use of instruments; as compass, chain, scale sextant, barometer, hydrometer, pluviometer, thermometer, telescope, microscope, etc., with their applications to surveying, protracting, leveling, calculating, excavations and embankments, taking heights and distances, specific gravity and weight of liquids, degrees of moisture, storms, temperature, latitude and longitude by lunar observations and eclipses.
>
> Eight weeks, mechanical powers, circles, conic sections, construction of bridges, arches, piers, railroads, canals, running circles for railways, correcting the errors of long levels, caused by refraction and earth's convexity, calculating the height of the atmosphere by twilight, and its whole weight on any given portion of the earth, its pressure on hills and in valleys as affecting the heights for fixing the lower valve of a pump;

> in calculating the moon's distance by its horizontal parallax, and the distances of planets by proportionals of cubes of times to squares of distances.
>
> Four weeks, in calculating the quantity of water per second, etc., supplied by streams as feeders for canals, or by turning machinery; in calculating the velocity and quantity effused per second, etc., from flumes and various vessels, under various heads; the result of various accelerating and retarding forces of water flowing in open raceways and pipes of waterworks, and in numerous miscellaneous calculations respecting hydrostatics and hydrodynamics.
>
> Four weeks, study the effect of steam and inspect its various applications—inspect the principal mills, factories, and other machinery or works which come within the province of mathematical arts; also study as much geology as may be required for judging of rocks and earth concerned in construction.

If these items be taken seriatim it required just twenty-four weeks, the length of the summer term, in which a college graduate might complete the course. And for all this was charged:

> Fees for instruction, including all lectures, experiments, etc.; also for use of instruments, apparatus, library and specimens, $4.00 for each subterm of four weeks.

Modern publicity men might take a lesson from the closing paragraph of this notice,—

> Gentlemen wishing to learn the outline of the terms of the Rensselaer Institute, are requested to pay postage on their letters; and they will receive this printed notice. I will state that I paid $54.28 in one year in postage for letters on other's business: some for our school course, more for advice about mines, minerals, and visionary products.

Civil War Ushers in New Era in Engineering Education.

During the next twenty years some five more engineering schools were established with a general enlargement of the curriculum. Then came the Civil War and the beginning of a new era in engineering education. By 1890 the civil and mechanical engineering courses of study had become almost fully developed.

The U. S. Department of Education Report for 1889–1890 gives this as the usual civil engineering courses at that time:

First Year.

1st Term—Algebra and Trigonometry, Chemistry (Lectures) Chemistry (Laboratory), Rhetoric, French, Mechanical Drawing.
2d Term—Analytical Geometry, Chemistry (Lectures and Laboratory), English Literature, French, Descriptive, Geometry and Drawing.

Second Year.

1st Term—Surveying, Analytical Geometry, Descriptive Geometry, Physics (Lectures and Recitations), German, French, Drawing.
2d Term—Surveying and Leveling, Calculus, Shades, Shadows and Perspective, Physics (Lectures and Recitations), French, German, Drawing.

Third Year.

1st Term—Railroad Engineering, Strength of Materials, Mechanics, Physics (Lectures and Laboratory), Stereotomy, German, Geology.
2d Term—Railroad Engineering, Mechanics, Machine Drawing, Stability of Structures, Physics (Lectures and Laboratory), Stereotomy, German Geology.

Fourth Year.

1st Term—Astronomy, Graphical Statics, Steam Engine, Hydraulic Engineering, Roof, and Bridges, Architecture.
2d Term—Engineering Construction, Details of Practice and Design, Specifications and Contracts, Sanitary Engineering, Geodesy, Thesis.

It will be noticed that modern languages is given a much more prominent part in this curriculum than in the present-day curricula; the same may be said of drawing.

Other subjects which were then required have been either abandoned or relegated to the elective list. The crowding out of general and cultural subjects by the technical is perhaps more evident in mechanical and mining engineering courses than in the civil.

Five- and Six-Year Courses.

As new discoveries were made and new inventions and new industrial methods developed, courses based upon them were crowded into the curriculum, and the languages and other non-technical subjects were forced out. When it became impossible to accommodate all these things men who saw whither we were tending tried to save the broadening and cultural features of the older curricula by advocating five- and six-year courses. But the four-year college period had become

TABLE V.

Showing the Distribution of Student's Time in Average Courses in 1892 and Courses Suggested by the Committee on Graduation Requirements.

	Civil.		Mechanical.		Mining.	
	1892.*	Com.†	1892.*	Com.†	1892.*	Com.†
Algebra and Geomety	250	‡	220	‡	250	‡
Pure Mathematics	1,490	1,000	890	1,000	630	1,000
Mechanics—Theoretical		500	450	500	450	500
Physics and Thermodynamics	670	1,000	1,530	1,000	350	500
Chemistry	500	250	470	250	1,080	500
Astronomy	180	100			40	50
Geology and Mineralogy	340	200	150		920	500
Biology	160	150				
Drawing	630	500	730	500	380	500
Materials of Engineering	280	250	170	125	250	250
Static Structures	450	750	30	100	100	100
Machines		75		375		75
Power		375	260	1,250		350
Surveying—Plane and Geodetic	570	550	70	75	540	400
Railroad Engineering	180	250		75		
Highway Engineering		50				
Hydraulic Engineerng	220	250	200		130	150
Mechanical Engineering	70	50		500	120	150
Electrical Engineering		100		250		150
Chemical Engineering		50		50		150
Mining Engineering	40		30		900	600
Ore Dressing					70	425
Architecture		100				
Social and Political Sciences	160	150	200	150	130	150
Shop Work	190		910	500	30	200
Language—English and Modern	560	500	460	500	480	500
Thesis	260		430		350	
Total	7,200	7,200	7,200	7,200	7,200	7,200

* Computed from data given in *Engineering News.*

† Suggestion of Committee on Graduation Requirements.

‡ Required for admission.

§ Hours of student's time—study, recitation and laboratory. Five hundred hours represent, practically, one exercise each week for an average school year.

so firmly established as the time necessary to secure a college education that the extended courses did not prove popular.

The *Proceedings* show a great many papers dealing with various phases of the courses of study, some of them very carefully worked out. In 1904, a committee reported very fully on the minimum requirements. This report was discussed at length the next year and some revisions made. With very few modifications, and they toward the line of the more technical, these may stand for the present engineering curricula in civil, electrical, mechanical and mining engineering.

For the purpose of comparison the requirements recommended by the committee are placed in parallel columns with the average requirements of 1892 as computed from data in the *Engineering News*.*

While this comparison is made with the ideal courses suggested by the committee some thirteen years ago it shows that even at that time there was a filling up of the courses with purely technical subjects. The fundamental subjects of mathematics, physics and mechanics have about held their own. Algebra and geometry, formerly given the colleges, is now required for entrance. Thesis work has been dispensed with very largely and in only a few schools is it still retained as a required subject. So many courses are now offered that the elective system is necessary; the student thus having a choice among many purely technical subjects leading to specialized lines of engineering work.

Many writers throughout the proceedings complain of the crowding of the curriculum and Dean Anthony in his presidential address† seems to see the light of the dawn of a new day, for he says,

> The educational pendulum has now reached its extreme oscillation toward vocational education and is about returning toward that point

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* A series of articles on Engineering Schools in the United States, by the Editor; *Engineering News*, Vol. XXVII, p. 277, to Vol. XXIX, p. 138.

† *Proceedings*, Vol. XXII, p. 33.

which should mark a greater unity in the objects of education regardless of the diversity of paths which must ever tend to become more divergent.

COMMITTEES ON UNIFORMITY OF SYMBOLS FOR ENGINEERING TEXT-BOOKS, AND ON STANDARDIZATION OF TECHNICAL NOMENCLATURE.

This committee was raised in 1905 and after two years of good work was discharged and a new committee appointed. The new committee reports unfavorable to any action being taken at that time. In 1913, a committee was appointed to standardize technical nomenclature. A suggestion was made at the Iowa meeting that this committee investigate the matter of symbols. So in addition to the work on technical nomenclature, or as a branch of it, the committee is studying "symbols." There is no doubt but that some standardization of symbols is justifiable. Standardization comes as a matter of course after a time, and if the committee can only collect data showing which of the symbols are gaining preference, they will be doing a good work.

COMMITTEE ON INDUSTRIAL EDUCATION.

This committee was appointed in 1899 and made several excellent reports. Definite industrial education as that "which specifically fits one for an industrial vocation or profession," they outline a general scheme for the classification of schools into: 1. Private Manual Training Schools; 2. Manual Training and Art Public Schools; 3. State Agricultural and Mechanical Colleges; 4. Higher Engineering Colleges; 5. Monetechnic or Trade Schools; 6. Supplementary, Schools for Industrial Workers; 7. Higher Colleges of Commerce.*

The preliminary report of this committee, in which the classification scheme occurs, together with several papers by members of the committee and others called out by the work of the committee constitute valuable contributions to the history and growth of industrial education in this country, and no doubt had its influence, with other agencies, in accelerating the adoption of vocational training in the public schools of the larger cities of the country.

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* Preliminary Report of the Committee on Industrial Education, *Proceedings,* Vol. VIII.

Committee on Statistics of Engineering Education.

The statistics of engineering education are extremely important to any one who desires to study the history of the subject. And until one goes into the matter he cannot realize the dearth of such statistics. The work of the committee has usually been an effort to supplement statistics prepared by the office of the United States Commissioner of Education. The labors of the committee have been well worth while. Though the influence of the committee and this Society has been instrumental in bettering the arrangement and classification of the statistics published by the U. S. Commission, there still remains much to be done in this line, and it would seem as though the best results might be obtained all around if the committee would persuade the commission so to arrange its collections as to separate the statistics of engineering students from those of other colleges. From the reports of the commission it is impossible to obtain even the number of students in the United States pursuing a technical engineering course. In the last volume of the *Proceedings* (XXIV) the committee publishes an extremely interesting compilation which it has secured from the Bureau of Education. But this sort of data ought to be a regular part of the commissioner's annual report and we should not have to ask for it.

History and Biography of Engineering Education.

Dr. Waddell, a number of years ago, suggested a committee on the subject of history and biography. A committee was appointed to consider the subject, and after due deliberation in 1905 reported in effect: (1) That we urge members to prepare and present for publication historical and biographical articles; (2) That we urge members to make indices of all such articles coming within their knowledge and present them for publication; (3) Recommends that the program committee secure one or more papers each year of a historical or biographical nature; (4) Asks that the Council consider the advisability of offering prizes for such papers. The committee was discharged and nothing definite along this line has since been done. It would seem as though this work might once more be inaugurated, but instead of trying to write a definite history of engineering education the committee should begin by thoroughly indexing everything of a historical nature that has been published in our own proceedings. This would be sufficient for one year, and if a committee of six were at work require each member to read and index four volumes, which would not be burdensome. A second year they might begin with the oldest of our engineering periodicals; and follow these in succeeding years until all had been covered. Then, by use of Pool's and other indexes, cover the non-engineering periodicals. So the work might continue for many years, or some one may be able to suggest a better plan.

Committee on the Teaching of Mathematics to Students of Engineering.*

The committee through its chairman, Dr. E. V. Huntington, reported in 1909, 1910, and 1911. They submitted a very complete set of syllabi† covering the subjects of algebra, geometry and mensuration, plane trigonometry, analytical geometry, differential and integral calculus, and complex quantities.

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[*] "The committee was appointed at a joint meeting of mathematicians and engineers held in Chicago, December 30–31, 1897, under the auspices of the Chicago Section of the American Mathematical Society, and Section A and D of the American Association for the Advancement of Science, and on the suggestion of officers of the Society for the Promotion of Engineering Education who were there present, the committee was instructed to report to this Society."—Index Vols. I–XX.

[†] *Proceedings*, Vol. XIX. These have also been published and can be obtained from the Secretary in a separate Volume.

While all may not agree that these syllabi cover all those portions of pure mathematics that are necessary, and none of the portions unnecessary, all must admit that they form an excellent guide for mathematical departments in technical schools.

Similar syllabi are to be presented in other subjects. That in mechanics is practically completed.

The Joint Committee on Engineering Education.

In 1907, President D. C. Jackson presented a resolution inviting the governing boards of the American Society of Civil Engineers, The American Institute of Mining Engineers, The American Society of Mechanical Engineers, The American Institute of Electrical Engineers, and the American Chemical Society each to delegate two members to compose part of a joint committee consisting of such delegates and three from the Society for the Promotion of Engineering Education. The committee was "to examine into all branches of engineering education, including engineering research, graduate professional courses, undergraduate engineering instruction, and the proper relations of engineering schools to the secondary industrial schools or foremen's schools and to formulate a report or reports upon the degree of coöperation and unity that may be advantageously arranged between the various engineering schools."* The committee was asked to report in two years.

The next year a report was made treating largely of the personnel of the committee as made up, all of the societies having appointed delegates. It was also suggested that the interest of the Carnegie Foundation for the Advancement of Teaching and the General Education Board be enlisted, as these organizations were "in touch with the collegiate educational movements of the country" and had "statistics already in hand besides suitable vehicles for gathering additional statistics." The time for making their report was extended one

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* *Proceedings,* Vol. XV, p. 17.

TABLE VI.

Chronological History of Committee Work in Brief Form.

A, Committee appointed; *P*, Progress report; *N*, Committee discharged and a new one appointed; *D*, Committee discharged; *R*, Report but no record of appointment; *, No report.

Committee. Year:	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	1905.	1906.	1907.	1908.	1909.	1910.	1911.	1912.	1913.	1914.	1915.	1916.	1917.
Volume:	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	XIX.	XX.	XXI.	XXII.	XXIII.	XXIV.	XXV.
Entrance Requirements		*A*	*P*	*P*	*P*	*P*	*	*P*	*P*	*P*	*P*	*P*	*	*P*	*	*	*P*	*P*	*N*	*	*	*	*	*P*	*P*
Uniformity of Symbols			*A*	*P*	*N*	*D*																			
Industrial Education							*A*	*P*	*P*	*	*P*	*P*	*	*P*	*P*	*P*	*	*	*	*	*D*				
Statistics of Engineering Education								*A*	*P*	*P*	*P*	*P*	*P*	*P*	*	*	*	*	*N*	*	*N*	*P*	*P*	*P*	*
Text-Books for Libraries									*A*	*P*	*P*	*P*	*	*P*	*	*	*P*	*D*							
Requirements for Graduation										*A*	*P*	*P*	*P*	*	*D*										
History and Biography of Engineering											*A*	*P*	*P*	*D*											
Color—Orange—for Academic Costume													*R*												
Engineering Education, Joint-on															*A*	*P*	*P*	*	*	*	*	*P*	*P*	*P*	*P*
Engineering Degrees, Simplification of																*A*	*	*D*							
Mathematics, Teaching of																*A*	*P*	*P*	*P*	*	*N*	*	*	*P*	*
Laboratory Instruction, Improvements in																				*A*	*P*	*P*	*P*	*	*
Administration, College																				*A*	*P*	*P*	*	*P*	*P*
Mechanics, Teaching (Hydraulics)																					*A*	*P*	*P*	*P*	*
Physics, Teaching																									
Technical Nomenclature																					*A*	*P*	*P*	*P*	*
Coöperation in Engineering Education	(See Com. on Laboratory Instruction)																								
Coöperation with Secondary Schools																					*A*	*P*	*P*	*	*
Classification of Colleges																						*A*	*P*	*P*	
English																							*A*	*P*	*P*
Economics																							*A*	*P*	*P*
Civil Engineering																							*A*	*P*	*
Mechanical Engineering																							*A*	*P*	*
Electrical Engineering																							*A*	*P*	
Mining Engineering																							*A*	*P*	*P*
Institutional																							*A*	*P*	*P*
Chemistry																								*A*	*P*
Higher Degrees																									*R*

Note: The excellent synopsis of the work of committes, given in the Index Volume (I–XX) should also be consulted. Reports of committees are sometimes found in the Secretary's Minutes, when they may not be indexed.

year. No formal report was made, however, until 1914, when Professor D. C. Jackson made a statement of progress,* to the effect that several attempts had been made to collate information from college catalogues; that an appropriation had been made by the American Society of Civil Engineers, but no information suitable for the purposes of the committee had been obtained. The Carnegie Foundation had then been invited to undertake the task and that the Foundation had appointed for this purpose Dr. C. R. Mann. Dr. Mann took part in the program of the meeting and all who heard him agreed with President Anthony when he stated that "he had become enthusiastic over the prospects of the results of the committee's work although he was not so at first."

You are all acquainted with the work of Dr. Mann, whose reports as a member of the committee have been the predominant feature of several meetings. His work has produced more discussion among engineering teachers and engineers than any one thing that has appeared in a quarter of a century and it will no doubt also be extremely far reaching in its effect on engineering teaching.†

Other Committees.

It will not be necessary to review the work of other committees‡ nor mention the several which were appointed two years ago, when the Society, at the suggestion of President Jacoby, took a step in the direction of more scientific committee work and less of the haphazard hit or miss kind. The Society, in going largely to the committee method of doing business, does not expect each committee to report fully each year; but does hope to have practically completed reports from one or two committees. It does not mean, either, that when complete reports are made that the committees should necessarily be discharged. They may be retained for the purpose of watching the trend of events in their own domains and of suggesting modifications to former reports whenever the exigencies of the times demand or warrant them. Neither will it be necessary to detail the work of those meetings, which were largely given over to particular subjects; such as, the papers on education for leadership; the meeting devoted almost wholly to the organization and management of laboratories; the symposium on highway engineering; and those magnificent papers, filling an extra volume, on efficiency.

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* *Proceedings,* Vol. XXII, p. 2.

† The results of Dr. Mann's investigations have been rewritten and published by the Carnegie Foundation for the Advancement of Teaching, as Bulletin No. 11, 1918, under the caption, "A Study of Engineering Education."

‡ See Table VI.

So much, then, for the survey of the past. It is impossible thoroughly and properly to sum up the work of twenty-four years in one short hour. If I were to criticize it, I should say, there has been in our meetings and proceedings too much of the *what* to teach and not enough of the *how*. Herein will lie the help which we expect from Dr. Mann's studies, and while no two persons can teach exactly alike, they can obtain a knowledge of broad pedagogical principles from the same source and these will, like handwriting, become personal and characteristic.

A Reconnaissance.

One of the objects of the study of the history, growth and development of any subject is to determine its future trend. We may not be able to see the movement of the hand of a clock, but by observing its positions at periods sufficiently far apart, we conclude it does move and we determine the direction of motion. The primary current may be so slow and sluggish as to be scarcely discernible, but still it will induce a current which manifests itself with great ferocity. If the measure of an educated man is determined by his ability for rapid and conclusive analysis, then the study of history will have an important place in his culture; it may be looked upon as the primary current which induces, as a secondary, this power of rapid and conclusive analysis.

CROWDED CURRICULA TO BE EXPECTED.

In the early days of engineering education, knowledge was the prime requisite. Data had to be collected, had to be arranged and classified. The amount of known things pertaining to engineering proper was so meager that it formed a minor part of the school curriculum. The course of study was based upon the curricula of the classical colleges; dead languages were replaced largely with applied science. The ultra conservative school man looked with disgust upon the innovation and for many, many years refused to consider engineering a learned profession. But the demand for engineers in a rapidly developing world was great. Knowledge of the subject matter continually accumulated. New ideas, new inventions, new methods, demanded "places in the sun." History, literature, modern languages, were overpowered and surrendered to the autocratic sway of the technical. Soon the curriculum could no longer accommodate the many subjects asking entrance. The bonds were burst asunder and eclecticism, specialization and differentiation resulted. Adjective engineering overrun the whole country like dandelions the lawns in the springtime. From the original bifurcation of engineering into civil and military has grown scores of branches each with its qualifying adjective. Men of broad vision began to fear the narrowing influence of excessive differentiation. They suggested lengthening the courses in order to bring back some of the non-technical cultural subjects crowded out. Others welcomed the increased length as it enabled more technical subjects to be covered by one student. The results of the five- and six-year courses have not proven to be satisfactory in practice. Students refuse to spend five or six years in college when they can get a degree and a job in four. Then perhaps shallowness is no worse than narrowness. Under pressure the bottom will scour out or the banks wash down.

If the time necessary for a degree has been fixed, and it seems to be in American colleges, either there must be allowed the multiplication of courses, or the educational procedure must be speeded up. Could the speeding up process be accomplished by an application of the principles of business management? Could moving pictures, for instance, be taken of the various schools and their methods, the information charted and a route map, which may cut off a few seconds here and a few seconds there, be made? This not for the purpose of reducing the number of hours in the college course —that is assumed to be fixed—but to see if space cannot be gained to slip in a lost cultural, or, more likely, a new technical subject. Dr. Mann (*Proceedings,* Vol. XXV, p. 125) suggests that a speeding up process might be accomplished by a greater correlation of the work of the freshman class with engineering subjects. He would introduce in the freshman year "a course which might be called 'elements of engineering,'" dealing with problems in mechanics, transmission or energy or other concrete definite problems "closely connected with mathematics and drawing so that the three would be three phases of the same thing."

Notwithstanding the greatly increasing number of subjects, there are those who believe with Professor Swain that the "increase in number of studies has led to the subordination of the exceptional man to the average man." While others are of the opinion that over-specialization is a menace, that broadminded men are demanded and that every engineering course should be firmly based on the fundamentals.

With the tremendous increase of subject matter in engineering as a whole and with the broad diversification of the same, and the further fact that this is bound to proceed at an accelerated rate in the future, we may expect continual crowding in the hives with the consequent swarming of curricula.

There is also a tendency to consider more carefully the intimate relation existing between engineering and the social sciences. In the past engineering was considered almost wholly the application of mathematical and physical sciences to the problems of construction. In the future more emphasis will be laid on the needs of construction and the reasons therefore.

Social science and economics are coming more and more to be considered legitimate subjects for the study of engineers. The responsibility of the citizen for government and the duties he owes to the community in which he lives, and to those who may be associated with him or be placed under his direction is beginning to receive more than incidental attention.

The Pedagogy of Engineering Education.

More thought, in the future, will quite likely be given to what may be termed the pedagogy of engineering education. The big work of the next few years of the Society for the Promotion of Engineering Education ought to be of this character. It can be divided into two general heads: "What to teach" and "How to teach." Each of these will be given due consideration by the committees now, and which shall, in the future, be appointed.

Intelligence Tests.

The work of educators and psychologists during the past few years in carrying forward so called "Intelligence Tests" to determine the ability of a pupil to learn may lead to a method of, or series of tests for, determining what subjects the student is best fitted for. This Society should, and from the interest evinced during the past few years in the labors of Dr. Mann, will render every service toward the perfection of such tests, or prove beyond a peradventure of doubt their fallibility. It is to be hoped the tests may themselves be tested, for, if successful, the paying in students' time will be almost incalculable. This, though, means lots of work, painstaking work. The whole matter is yet in a very crude condition, but the chances of success are much more hopeful than were the chances of wireless telegraphy when this Society had its origin.

How to Teach.

The writers of papers have avoided to a great extent discussions of how to teach their particular branches. Possibly this is due to the inherent modesty of the members. It would be well if there might be more explicit statements concerning the "how to teach" from the older and more experienced for the benefit of the younger teachers. The intelligence tests may serve a useful purpose here, too. For, if a short test can determine a student's ability, then will it be easy to collect students of like ability into the same class and gauge the lessons assigned according to that ability.

Education for Line and Staff.

Dean (Major) Stout, of the University of Nebraska, uses the above caption to designate a scheme he has for training engineering students according to their abilities. Some will only be able to prepare for the simpler engineering operations—for example, machinists, plant operators, or instrument men; while others may become designing engineers and general managers of large concerns. During the earlier years of the college course he would have the students take up the easier learned subjects or those within their comprehension, and train them for "line" positions; carrying on in the later years to those subjects which train for the "staff" positions. The intelligence tests may be able to point out at once into which of these classes the student should be placed, thus saving much time in preliminary study.

The "motivation" of studies is receiving some attention. This may, and has in some cases, been done successfully in mechanics, mathematics, chemistry, physics, etc., by placing before the students practical engineering problems and developing the theory as needed; in English composition by having students write about those subjects directly connected with their engineering experience. It, of course, means that the teachers of such subjects must be engineers. In mechanical engineering, shop and business management is attempted to be taught in connection with manual training and other shop work. In former days the schools were anxious to help out manufacturing by training artisans, now they are apparently devoting more energy to the training of officers and managers.

CONCLUSION.

It has not been the desire to give detailed statements of each year's work of the Society, nor to make long quotations. The *Proceedings* are available to most of the members and will well repay their examination, especially by the younger teachers. As a further constructive criticism, the suggestion may be made that the official, fiscal and statistical year should have a definite time of beginning and ending. This should be sufficiently long enough before the annual meeting for the officers to make their reports complete. Some of the reports are up to August, some to June and some to March. Why not have them all, hereafter, begin at a fixed date?

In conclusion, it may be stated that the trend of engineering education has been upward. More and more is being demanded of the schools and the schools are responding nobly. They may be given great credit for the present high standing of the profession, and in turn the high standing of the profession has had a very beneficial reaction on the schools. It would be well if more practitioners would attend our meetings and give us the results of their experience, that we might carry practical ideas back to the students we are training.

ADDENDUM.

The above had been rough drafted for the meeting of 1917, which was to have been held at Northwestern University, Evanston, Illinois. But upon April 6, of that year, as is well known, the United States declared war against Germany. The meeting at Evanston was declared off and in lieu thereof a short meeting was held in Washington. The volume of the proceedings for 1917 is one of the smallest of any of the twenty-five so far published. But the work of that meeting was by no means negligible. Secretary of War, N. D. Baker; Chief of Engineers, U. S. Army, General W. M. Black; Director of the Bureau of Standards, S. W. Stratton; U. S. Bureau of Education Specialist, S. P. Capen; members of the Advisory Board and others were the speakers. Practically the entire two days were given to discussing how the engineering schools could help the government win the war. As a result of this meeting and other educational conferences, many of which were participated in by Secretary Bishop and other delegates of the S. P. E. E., the government appointed a committee on Education and Special Training, consisting of representatives of various branches of the war service and several civilian educators to organize and administer all governmental educational war work. This committee first organized the engineering colleges and trade schools along industrial lines. Drafted men were sent to these schools to take up many lines of industrial work needed in the army. The courses given were short and snappy. The methods of teaching and assigning work were much different from those in vogue in the conservative engineering colleges. The work was eminently satisfactory.

At the solicitation of school men the government offered to give deferred classification to students in technical courses upon recommendation of the school authorities. But for keeping up the attendance of the schools this proved to be a failure. The young men, being red-blooded and patriotic, refused to accept exemption; they did not even desire it, they wished to avoid the very appearance of being slackers, and the quicker they could get to pumping cold lead into the Huns the better they would be pleased. On the other hand, there were many educators who would not think of asking exemption for their students. The writer was one who early advocated the enlistment of the college man and the detailing of him back to college for special training. (See last paragraph on p. 18, 1917 *Proceedings.*)

S. A. T. C. ORGANIZED.

The agitation of the school men kept before the War Department the needs of the schools; meantime the War Department felt it could not successfully prosecute the war without educated young men for officers. It saw in the organization of the schools the machinery ready at hand for the training of officers and industrial technicians, hence contracts were entered into for the utilization of the organization, plant and equipment of the several schools, also for the housing and subsistence of the soldier students under most rigid sanitary regulations. The instruction, as mentioned above, was largely along industrial lines and later this branch became Section B of the S. A. T. C. It proved to be so satisfactory that the government thought it worth while to expand the scheme so as to take in all university men. There was consequently established in colleges registering 100 or more men units of Section A of the Students' Army Training Corps. Under the regulation selected young men who were physically fit for military service, eighteen years of age or over, and had been accepted as students in a college requiring a high-school preparation or its equivalent for entrance, were to be allowed voluntarily to enlist in the S. A. T. C. and thus to become bona fide soldiers of the United States. Before this went into effect, however, the draft age was lowered to eighteen years; but the War Department wished to continue S. A. T. C. for registrants, because the government, looking ahead to a possible long war, needed trained men to fill important positions in the army, and later, educated men to carry on the work of readjustment after the fighting stopped. The colleges having units of S. A. T. C. were, in other words, to serve as reservoirs from which a constant supply of officer material could be drawn as needed. They furnished splendid places for the trying out of these men. Arrangements were under way for the application on a broad scale of "intelligence tests" to determine the character of the work for which the student soldier was best fitted, and his future training was to be modified accordingly.

Incidentally, it may be noted that intelligence tests were made upon thousands of soldiers in the cantonments with eminent success. Psychologists are strongly of the opinion that the validity of such tests have been demonstrated. Our Society should by all means raise a committee to study more thoroughly these tests, and if found to be what the psychologists claim for them they should be standardized for engineering students.

In order to popularize the S. A. T. C. movement a publicity campaign under the direction of the American Council on Education, of which the S. P. E. E. is a constituent member, was inaugurated. The estimated probable enrollment in the United States was 111,097; the actual enrollment was in excess of 250.000. While this sudden influx of students more than kept the enrollment of the schools up, nevertheless, on account of the required changes in courses and methods, on account of the necessity of housing and feeding the students, the schools were hard put to it, and considerable dissatisfaction due to these more or less chaotic conditions existed in many schools.

Some Reasons for Failure of S. A. T. C.

The general plan of the S. A. T. C. was excellent. The students were to receive regular military and educational training, a definite number of hours per day of each. Had the plan been carried out in its entirety, it is thought by those who have made a close study of the work, it would have been extremely successful. In addition to the unpreparedness of the colleges the following causes may have been conducive to the feeling of dissatisfaction with S. A. T. C.: First, there was considerable delay at the beginning of the school year because the process of induction was slow; the military blank forms were not forthcoming; the work was new to the young, inexperienced officers in charge; the students had not become accustomed to the new life, and class and study periods were not definitely arranged. Second, about the time these difficulties were overcome the epidemic of influenza struck the camps, thousands of student soldiers had to go to the hospitals, excitement ran high, and matters became disorganized.

Third, just as everything was again beginning to become stabilized the armistice came. Students, though sufficiently patriotic to submit to military supervision and restrictions in time of war when there was real need believed as soon as the war was over they should be restored to their old time freedom of movement and action. They were actually glad when their discharges came.

Some day when time lends perspective the true history of the S. A. T. C. movement will be written by someone capable of setting forth its good and bad points in a systematic, concise manner. We, who had something to do with it, may be proud that we rendered every help possible to make a success of the greatest educational experiment ever attempted. An experiment stopped by a great world blessing, the signing of the armistice. Organization had not been completed; military men inexperienced or not wholly in sympathy with the educational side were in command; and the inflenza epidemic and various other causes prevented a fair try out. Educators, as a rule, were glad to give it up, but some there are who yet believe there is much good in the principle of having students, especially in the lower classes, under rigid discipline; that eventually the dormitory system will take the place of the military barracks and that facilities for supervised study will greatly enhance the efficiency of our educational institutions, that though seemingly put to death by the ending of the war, its good points may still live and influence the world's education for all time to come.

DISCUSSION.

C. J. Tilden: This is one of the most interesting, instructive and valuable papers that has ever been published by this Society. I am sure that I voice the sentiment of the entire membership in expressing the gratitude and appreciation of the Society to Professor Chatburn for preparing it. One needs only to glance through it to see the great amount of work that has been put upon it, and the admirable and valuable shape in which it now stands.

It is a remarkable record really; and perhaps the first thought that comes to one on reading it, especially in view of the particular time we are in now, is what the next twenty-five years are going to bring to the Society and to the field of education that we represent? I am not going to attempt prediction, but there are one or two points that come to mind, and one of these that I should like to emphasize is touched on on page 26 of this paper in what Professor Chatburn has to say about history and biography. Not only is the history of engineering education important, but I think it is the duty of this Society to take up the whole question of the history of engineering activity. It is a profession that has a wonderful history, a history that goes far back into the past and it is a subject that has been much neglected. It could certainly be made a most valuable part of the inspiration and education of college students. They are particularly susceptible to the records of the achievements, the study and past performances of men in the profession they seek to enter, and that is something that ought to be taken up more in detail, and something that this Society could well foster.

Another point is also one that has had suprisingly little attention. Professor Chatburn speaks of the emphasis that has been placed, in the past quarter century's record of the Society, on what to teach rather than how. And if the "how" is important how much more so are the personal qualifications of the teacher. But there is no general specification for a teacher of college grade, no attempt anywhere to formulate his training, experience, personal qualities, etc. For a profession that is severe and exacting in most of its relationships, we are singularly haphazard in picking our teachers, the very place it would seem where the most severe and most exacting requirements should be demanded.

This need for plans and specifications of a strict engineering sort, for the guidance of those who could become teachers as well as for those who must choose them, is one of the greatest needs today in the development of engineering education.

If something of the sort could be done it would easily be the next big step forward. It could hardly be done by this Society alone, but in coöperation with the national engineering societies a formulation could be accomplished that would be satisfactory—at least for a time—and carry great weight of authority. This suggestion was made in Minneapolis last week at the meeting of the Development Committee of the American Society of Civil Engineers. The expressed desire of the national societies to make their organizations more effective and useful would lead to a ready and prompt response from all of them if the Society for the Promotion of Engineering Education expressed a wish for coöperation or help.

I want to express again my own great satisfaction and profit in reading this paper, and that I am sure is something we all feel.

R. L. Sackett: Mr. President, I have enjoyed very much this survey of the history of the Society.

I happened to be one of those present at the first session when this Society was organized, and I shall never forget the inspiration from the high ideals expressed by those members of the profession there present. We look back upon them and realize that they were the leaders and that they had the vision of the Society.

I want to emphasize one thing. In the earlier session of this Society there was presented to its membership the ideals of engineering education; and where the ideals have been presented and the defects shown and suggestions made for improvement there has been an enlarged measure of success, it seems to me.

The Society has on occasions attempted to suggest action on specific matters. I shall illustrate by over emphasis: For instance, where we have attempted to unionize or suggest a specific procedure or the number of hours to be devoted to a given subject we have not succeeded. Where we have pointed out defects and suggested what the ideal should be we have won our greatest success. Take English for instance. It is not important it seems to me for the engineering schools that this Society should specify the quantity of English. But it is highly important that now somehow we should coördinate with the teachers of English to engineers, in order that we might get a closer coöperation between the teachers of English and the teachers of engineering, so that each might understand the ideals and the ideas of the other.

I submit again that the most important thing in the history of this Society is the constant maintenance of high ideals, suggestions of how improvements can be made, without any attempt to specify what the content of subjects for entrance or in the curriculum should be.

J. J. Flather: I wish to call attention to a paragraph on page 32, in which it is stated that the results of the five and six years' courses have not proved to be satisfactory in practise. At the present time the question is debatable as to whether it is desirable to open up our courses and extend them to five years. Personally I am a firm believer in a five years' course for engineers. If we are to give our engineering students the necessary preparation for engineering work and at the same time fit them for citizenship and for those positions which an educated man ought to occupy in his community, we must introduce subjects other than engineering, which in the crowded state of the curriculum of four years seems almost impossible, therefore, I think a five-years' course is the logical and proper course. From an experience of eight or ten years at the University of Minnesota, when we have had seventy to seventy-five per cent. of our seniors come back for the post-senior year, it would seem as if the students themselves were in favor of the longer course.

At the same time even in the five-years course we should use every possible means to speed up the process, as Professor Chatburn has mentioned. It might be interesting to state here that one way in which we are accomplishing results that were undreamed of five or six years ago is by using the task and bonus system applied to various forms of our work, not only in the shop but in the drawing room as well, and to a certain extent the class room; but particularly in our shop and drawing room, in which we are using the typewriter more than ever before. Each student in the drafting room for instance is assigned to project clearly stated; cases are referred to—references, magazines, books, periodicals, textbooks and others in which the page and reference may be given so as to save the student's time. A time limit is set on that project, the date is given when it is to be finished, and the student is urged in every way possible to save time, and whatever he saves counts as a bonus.

In the upper classes we find this to be the case: that the men are doing thirty to fifty per cent. more work than they ever did before. If they wish to take the time saved as a bonus, they can spend that time on something else, because they have accomplished the work, and they have done it in a shorter time; or if they desired they can go on and do more work, accumulating a bonus in that way. They have learned to think more expeditiously; to run a machine more intelligently, and to draw with less loss of time than formerly.

Now, in addition to that, grades are assigned for efficiency in this work. A man may secure such a grade as will give him a thirty-three per cent. additional credit so that he will graduate in a shorter time, or as it works out he may use those additional credits for graduation.

Those are some of the ways in which we are trying to expedite the work and we are not able to accomplish much more and with better results for the individual than ever before.

TEACHING SAFETY IN ENGINEERING SCHOOLS.

BY GEORGE W. CASE,

Professor of Sanitary Engineering, University of Pittsburgh.

Workmen have been injured in the course of their daily labor for as many centuries as we have had men toiling for their food and shelter. When the causes of these injuries could be traced to the negligence of the workman or his fellow workman, no one felt any particular concern, for of course, certain chances had to be taken and in some kinds of work more than in others. If it were quite evident that the fault lay with the employer, as our civilization progressed, there was a legal battle and a damage suit to be won or lost.

About twelve years ago the heads of several industrial corporations started investigations to determine the causes for the large number of injuries to workmen that were occurring in their plants. Accompanying the realization that these injuries would gradually develop in the minds of the public, an opposition to the industries represented, was an objection to the waste and suffering resulting therefrom. These investigations indicated that many injuries from so-called accidental causes were preventable and that it was possible and highly desirable to reduce their number. It was decided that although the workman might be considered legally negligent when he put his hands into unguarded gears, it would nevertheless be best to guard the gearings and the plants proceeded to guard them. Danger points were thus sought out and industrial operations began to be studied from the standpoint of safety for the workman, as well as speed and economy of production and quality of the product.

At about this time workmen's compensation laws came along and the movement gained additional converts. Of necessity the progress was slow, since plants doing such work had to depend upon their own experience, for all the knowledge they could bring to bear on the several problems involved.

The first step towards active coöperation was taken when a small group of young electrical engineers met in the city of Milwaukee early in the fall of 1912, to discuss ways and means of installing mechanical guards to prevent electrical injuries. One engineer detailed the methods he employed in safeguarding his work, another described his procedure, then a third and a fourth and the technical difficulties went the rounds. Out of the debate a national movement was born, because as these men reasoned, the underlying principle of safeguarding human life is the same in a steel plant, a woodworking shop, a railroad and in the depths of a mine. As a result, officers were elected and an organization was completed that in 1913 became the National Safety Council, a clearing house for safety information.

Each year since its organization, this council has held a meeting at which members gather to discuss experiences of the preceding year and gain ideas and inspiration for the year to follow. Speakers of wide experience bring thoughts which tend to broaden the horizon and with all, the proceedings of these meetings, or congresses, as they are called, take a prominent place in the literature on the subject of safety.

This council was originally formed to promote the idea of mechanical safeguarding, of which a few of the more important items are structural design of buildings, including installation of proper avenues of approach for employees; correct heating, lighting and ventilating facilities; satisfactory sanitary appliances; adequate aisles and exits; non-slip floors and stairs; standard rails and platforms; stair and walkway approaches to cranes and window cleaning platforms; clearances between immovable parts and cranes and cars; fire fighting equipment; and the checking of compilations of safe loads and stresses. Then comes the consideration of operating machinery, which not only covers the careful preparation of specifications for new material and machines, but also requires the covering of all gears, protection of belts, shafts and revolving parts, safeguarding against contact with electrical equipment, regular inspection of cranes, cables, slings, elevators, boilers, control and other apparatus.

Mechanical safeguarding rapidly incorporated the operation of the machine and accessory equipment, sanitation of the workman's surroundings, protection of his eyes by goggles from flying missiles and by the aid of scientifically colored screens from light rays coming from metallurgical or high temperature operations, his protection from dangerous fumes and has ramified into an almost unlimited field, until today the department having charge of this work is more thoroughly acquainted than any other, with general plant conditions. The recognition of this fact by the officials of plants well organized to carry forward this activity, is evidenced by the fact that more promotions to the positions of manager and general superintendent have come to the heads of the safety departments in the last few years than to those of any other department.

The successes accompanying the work for the prevention of injuries has been striking in many plants where intelligent effort has been made, as the following selections indicate:

The records of the United States Steel Corporation show that by using the injury rate of 1906 as a basis, and including cases where more than 35 days' time was lost from work, that in the nine subsequent years 14,967 of its employees were saved from death or serious injuries by its safety work. These records also show that although the cost has totaled millions of dollars the corporation has saved through the reduction of casualty settlements, an amount double this large investment.

The fatality statistics of the munition plants of the E. I. duPont de Nemours & Co. show as a result of their safety work, that for full-time employees their accident rate has been lowered as follows:

In 1908 for an average payroll of 3,817, fatalities amounted to 9.17 per 1,000 employees. At the end of this year safety work was begun.

	Employed.	Fatalities per 1,000.
1909	4647	5.38
1910	5466	5.66
1911	5241	3.24
1912	5391	2.04
1913	4659	4.72
1914	4109	1.70
1915	46475	2.04
1916	49326	2.41

In 1910 on the railroads of this country there were 217 employees killed out of every one hundred thousand men employed, while in 1916 there were 117 killed out of each one hundred thousand employed. This is a reduction of 47 per cent. and with injured men, although the rate was much greater the reduction amounted to 46 per cent. On the New York Central Railroad, according to its General Safety Agent, the reduction in number of employees killed was 35 per cent. in 1916 as compared to 1913 per million tons of freight carried one mile, and in injured a decrease of 20 per cent. on the same basis. The Chicago and Northwestern Railway in a six and one half year period saved the lives of 293 of its employees and including all cases of more than one day's disability prevented injuries to 15,769 employees.

The following figures just received from the National Safety Council show the results from safety work done by a few of the companies thus engaged:

	Percentage Reduction in Number of Injuries from Accidental Causes.
The American Smelting and Refining Co.	90
Bucyrus Company	65
Cadillac Motor Car Co.	69
Eastman Kodak Co.	80
Illinois Steel Co.	70
Mare Island Navy Yard	75
International Harvester Co.	68
Chicago and Northwestern Ry.	66

Accompanying these figures was a statement that they should not be considered as comparing the record of one company with that of another, but as an indication of what progress has been made by the use of safety methods by individual companies.

A comparison which may appeal more strongly to stockholders, is that of the A. E. Staley Manufacturing Co., who in one year by safety methods reduced its compensation and medical costs from $1.87 to 75 cents per one hundred dollars payroll and of Fred T. Ley and Co., general contractors, who obtained a direct reduction of 33.2 per cent. in insurance costs for all work in the State of Massachusetts, on the basis of their excellent injury record maintained over a period of 45 months. The 100 per cent. dividend made by the United States Steel Corporation on its investment in safety work amounting to millions, was probably not viewed unfavorably by persons whose money is invested in this enterprise.

The following list of slides showing a few of the activities of the Safety Department of the Westinghouse Electric and Manufacturing Co. of Pittsburgh, should prove interesting as illustrating what one engineer is doing to improve working conditions, for the thousands of persons employed in this plant and insure that at the end of their working day they will not be returned maimed to their families.

1–12. Guard of circular rip saw.
13–15. Guard of cross-cut saw.
17. Hand crane guarded against overturning.
18–19. Emery wheel guarded.
20. Exposed gearing.
21. Gearing fully guarded.
22. Belt guarded.
23. Belt guarded.
24. Temporary belt guarded.
25. Pulley guarded.
26. Belt in temporary location guarded.
27. Electrical hazards reduced.
28. Safe handling of high tension fuses.
29. Unusually hazardous part of plant isolated.
30. Switches improperly guarded.
31. Better practice in guarding switches.
32. Switches conveniently locked.
33. Starting box guarded.

Operations Made Safe.

34. Suction device for punch presses.
35. Use of suction device.
36. Same.
37. Suction device probably saved a hand.
38. Other devices for handling punchings.
39. Same.
40. Punchings removed by compressed air.
41. Double suction device.
42. Use of double suction device.
43. Rear support of double suction device.
44. Guard of automatic feed press.
45. Fingers cannot get under guard.
46. Operator protected from effect of fumes. and spray of shellac.
47. Simple tools.
48–49. Acid jug.
50. Safe ladder shoe.
51. Safe practice.
52. Girls well guarded.
53. A well ordered yard.
54. A safe way to pile rounds.
55. A neat reflector guard.
56. The same.
57. A blood poisoned hand.
58. Waiting to be treated.
59. Operating room.
60. The way it should be done.
61. Convenient and clean.
62. Many plants have an X-ray machine.
63–64. Fire drills are often practiced.
65. The dining room.

It was found early in the development of this work that only a small reduction of accidents could be accomplished by mechanical safeguards alone and that a campaign of education was needed to accomplish the results desired. The educational campaign has been generally carried forward by means of safety committees made up of men representing all departments in the plant. The value of these committees was early sensed and they have become an established adjunct in the safety work. Due to these committees, probably the greatest benefit derived from accident prevention work in the operation of industrial plants, has been obtained through the friendly discussions of employees and employers. The loyalty of the employee does not suffer when he learns that his employer has a real concern in his wellfare and it often comes as a surprise to the employer to learn of the real interest many of his employees take in the prosperity of his enterprise. This rubbing of elbows about the conference table, where matters of mutual interest are considered in a helpful spirit, does much to promote the harmonious feeling so desirable in our industrial life.

This need of education has not been confined to the men, for employer, superintendent and foreman have many times been the stumbling blocks in getting results, even after considerable expense has been incurred for this purpose.

On the premise that most engineering graduates eventually become executives in industrial organizations or hold positions where they have charge of the design of structures and machines, and plan layouts of industrial and construction works, etc., it is evident that the fundamental idea of safety for the workman should be so incorporated into their thoughts in connection with plans and processes as students, that their point of view is established before they arrive in positions of responsibility. Machines should be thoroughly guarded or as thoroughly as experience and ingenuity allows, before leaving the manufacturer, which depends largely upon the designer. Men must be lead to keep them in the practice of the best methods, which leadership devolves upon the executive. The surroundings of men at work must be healthful, safe and convenient; in fact much depends upon the engineer in obtaining the best results in this field. With this view in mind, the National Safety Council in the fall of 1917 appointed a Committee on the Promotion of Safety Education in Technical Schools and Universities to study this subject and submit recommendations and this committee in turn appointed sub-committees, at meetings attended by representatives from faculties of Eastern and Western universities.

The following committee was appointed by the National Safety Council:

Albert W. Whitney, general manager, National Workman's Compensation Bureau, *Chairman.*

Dexter S. Kimball, dean of Sibley College, Cornell University.

Arthur H. Young, manager of industrial relations, International Harvester Co.

S. B. McCormick, chancellor, University of Pittsburgh.

C. P. Tolman, chairman, Manufacturing Committee, National Lead Co., New York City.

At the meeting of this committee at New York City early in March, 1918, attended by representatives from Eastern Technical schools and Universities, the following committee was appointed:

Dexter S. Kimball, dean of Sibley College, Cornell University, *Chairman.*

Professor George H. Follows, Carnegie Institute of Technology.

Professor A. S. Kinsey, superintendent of shops, Stevens Institute of Technology.

Professor F. P. McKibben, Lehigh University.

Professor G. F. Blessing, Swarthmore College.

The following committee for western universities was appointed at a similar meeting in Chicago, at the end of the same month.

C. H. Benjamin, dean of engineering school, Purdue Univ., *Chairman.*

Pres. John T. Faig, Ohio Mechanics Institute.

Professor J. A. Polson, Michigan Agricultural College.

Professor J. C. Roberts, Colorado School of Mines.

Professor F. H. Sibley, University of Kansas.

The following committee was appointed to review recommendations made by other committees and standardize practices:

D. S. Beyer, vice-president, Liberty Mutual Insurance Co., Boston, chairman.

C. P. Tolman, chairman, Mfg. Com. National Lead Co., New York City.

Dexter S. Kimball, dean of Sibley College, Cornell University.

R. J. Young, manager, Department of Safety and Relief, Illinois Steel Co., Chicago.

One of the first questions coming before these committees was safety work in the shops of technical schools. Parenthetically it might be mentioned that shops in technical schools, which should be laid out with the view to point the way in best practice, are often woefully lacking in the simplest requirements for accident prevention. Based on recommendations submitted the first draft of a pamphlet on Safeguards and Safe Practices in School shops was issued in September, 1918. This pamphlet or handbook which has just been made available for distribution under the title "The Principles and Practice of Safety" contains a discussion of safeguards and safe practices for school shops, as well as a number of lecture syllabi to aid college professors in properly presenting the general subject to their engineering classes. Being written by a staff of experts, aided and advised by educators such as those acting on the above committees, it should prove of valuable assistance in training engineering students along this line.

In this pamphlet is a list of safety subjects, with the names of men available for a limited number of lectures. These men have been chosen on account of their special fitness to discuss the subjects assigned them. The lectures can be scheduled by correspondence with the manager of the National Safety Council with offices in Chicago.

Two ways are suggested by which this subject can be handled. One is to offer a course for the training of engineers for safety work; the other is for instructors giving courses in which the principles of safety apply, to incorporate these principles into the work given, in order that all engineering students may obtain a realization of what is being done in this field.

A course can be designed to train men for safety work, however it would be difficult to select students to take the course who would be qualified to carry forward the work after graduation. As the following statement indicates, this work has so many ramifications that few men are successful in spreading their interest to cover all the details.

The safety engineer must prepare specifications for the safety features of all new work and inspect all designs to determine need for safety devices; pass on the ones proposed and if need be furnish designs for devices that are required; regulate plant operations in order that safe practices will prevail; educate not only the men but often the executives in the principles of safety; not only look after the welfare of the workers while in the plant but take an active interest in their welfare at other times. The safety department usually has under its direction the playgrounds for children, the work of nurses in the plant and those who visit the homes, the propaganda for interesting the workers in the appearance of their homes, in the planting of gardens, and development of community pride and responsibility. Such work requires engineering judgment, executive ability, tactful approach and a heart full of human interest and appreciation. A justification, if one is needed for this wide range of activity has been brought out, in one instance, in connection with the Americanization Movement. The following statistics show the result in the prevention of injuries brought about by the teaching of English during the war in the endeavor to Americanize the foreigner.

The Ford Motor Company claim that injuries in its plants were decreased 54 per cent. by teaching employees to read factory notices and understand instructions.

The Semet Solvey Company say that they have paid out thousands of dollars a year for injuries which may be traced directly to the inability of the employee to understand English.

The Federal Department of Labor reports that for each 10,000 American born workmen in a large steel plant for a period of eight years, 21 were killed, and for each 10,000 non-English-speaking foreign born, 26 were killed. The figures for the permanently disabled, 28 and 65, respectively show greater discrepancy, and those for the temporarily disabled 858 and 2,035, one greater still. Moreover, while from year to year, the frequency of injuries among English-speaking workmen decreased, it was much less reduced among the non-English speakers; and the average severity of the temporary disabilities was greater among the latter.

It is not necessarily men of great engineering ability that are needed in this field; it is rather men who have an abundance of sympathy for their fellowman who are needed. Men having that fine fellowship radiating from them that everyone wants to talk the matter over with them, and with this quality so ingrained that they are able to detect it in others, in order that they can accurately choose for their subordinates the ones who will be successful in this work. It seems very doubtful, indeed, whether young men in college. at a time when they must choose their course of study, will be able to judge from a review of their qualifications, that they are fitted temperamentally and otherwise, to succeed in this work or whether work of this kind will hold great interest for them.

It would seem, therefore, that safety engineers should be drawn from the ranks of technically trained men after graduation, and only those selected who feel a real interest in the welfare of the workingman and his family.

The best service then that the faculties of technical schools can perform in this field, is to instill into their students the realization that the work they will do after leaving school will bear a close relation to that of others and that their success as designers, layout, construction and production engineers, and executives will depend largely on their making provision for the safety and welfare of the workmen on the job.

DEGREES.

BY E. O. LEUSCHNER,

Dean of the Graduate School, University of California.

I know your time is limited, and therefore I shall set forth very briefly the object of the remarks that I wish to present to you this morning. The object is to enlist your coöperation in a task that the Association of American Universities undertook a little more than three years ago. It relates to the study and development of academic and professional higher degrees.

This problem confronted us on account of the fact that we noticed from year to year a growing demand for new degrees in the different professions; and that institutions proceeded to organize curricula and adopt new degrees in accordance with their own ideas and not with the corporation of appropriate national professional associations, more competent to say what the curricula and the degrees should be. And in that connection greater emphasis was often laid on the degrees as an inducement for students to come than on the relation of the subject matter of the curriculum to the degree.

The time seemed to have come when we should review the activities of universities in regard to curricula and degrees on a large broad scale; not with the idea of standardization, because that would be detrimental to progress, but with the idea expressed by one of the previous speakers this morning of setting up some general ideals which should be observed in preparing the student for a particular profession, and then letting the institutions work out the details of these ideals and finally culminate the curricula with proper degrees based on common understanding. Your own Society has been a leader in this direction. In fact historically as far as I know you were the first ones to recognize the important work to be done in this direction.

In 1910 a committee of this Society made a report based on a study of existing curricula and degrees. That report has been of the utmost value to us because it hit the high places as far as the difficulties are concerned and served as a standard for the Committee of the Association of American Universities.

You were followed in this work very soon after by the American Medical Association. I suppose you are all familiar with the magnificent results that have been accomplished by the study of medical curricula and degrees. The American Medical Association has developed ideals. It has a common standard, and the curricula for medical schools have a distinct standing. Each medical school has worked out the common ideals in its own way; and, therefore, the natural competition such as should exist with reference to procedure in graduate study and research still exists, and in fact it is enhanced by this broader conception of ideals and working them out in different ways.

You yourselves have made some very important recommendations.

The Committee of the Association of American Universities has had several meetings, and at these meetings had the coöperation of the more important professional associations, in discovering the fundamental problems underlying, all academic and professional graduate activities of the universities. It is remarkable how common the difficulties are in all these activities.

A university composed of different colleges and schools must naturally have a certain general university policy with reference to all of its degrees, and it cannot let any particular college or school run amuck and follow its own inclinations or that of a small group of the faculty in setting up new distinct curricula and degrees. But all schools and colleges of an institution together, and they generally do, through their common bond.

As far as undergraduate curricula and degrees are concerned it is difficult to accomplish much on account of the individual traditions of different institutions; but as far as the graduate schools and advanced degrees are concerned which are of more recent date a great deal of coöperation has been secured, so that common ideals are followed on the whole.

Too many degrees exist. I exhibit here just two pages of degrees which our Committee collected. They are so numerous now that even a university officer has to consult the Commissioner of Education to find out what these letters mean.

It is an absurdity. If we university men do not even know what the degrees stand for then what is their national significance? And after all is it not the main purpose of a degree, aside from being a certificate of the fulfillment of certain ideals of training. To have a national significance representative of those ideals when an American appears in Paris or in London with a certified degree from an American institution that he is at once accorded his proper place.

Is that possible today even with you engineers, particularly with reference to the engineering degree? You have to immediately ask the question when you meet a C. E., "Well, from what institution?" And then you have to compare notes. We should strive at a national significance of degrees and should eliminate our own prejudices and preferences with references to those degrees.

Now, I have been using the word degree. We are more interested in ideals. The fact is that unfortunately we cannot get away from degrees. They have been accepted, and we are dealing, using the popular phrase, with a condition and not a theory.

It would perhaps be far more desirable if we could get rid of all degrees and have professional activities licensed on the basis of examinations representing national ideals. But you, of course, recognize that such a plan would involve additional difficulties.

Now as to the details of the progress already made it would be impossible to put that before you today. I am just trying to give you the spirit of our work. I would like to refer you to the report of our Committee as it has been printed in the proceedings of the Association of American Universities. The Association includes twenty-three institutions maintaining organized graduate schools. The report was presented and discussed at the annual meeting of 1916. We have set forth certain recommendations.

I just wish to touch on one or two things in this connection, and then invite more specifically the coöperation of this Society.

At the present time as has been stated by one of the previous speakers there is a tendency to introduce a certain number of other subjects, presumably in liberal culture in addition to engineering work. Mind you, I am not using that term, because having studied seven years of Greek myself and nine of Latin, I think there is just as much liberal culture in engineering as in these.

But subjects for broadening purposes should be included, and it is of course very important that they should be introduced, languages and economics, etc., so that a man can talk of things outside of his profession and become a better, broader and more useful citizen than if he is a narrow specialists.

That applies to all, not only to the engineer but it applies in particular to the Latinist for purposes of so-called general culture.

Adding other subjects has tended to lengthen the curricula, and we have to move the engineering subjects forward. Five- and six-year courses are in the making, although you as a body have no definite idea what they should be.

Why not find out? Why not get together and find out what the ideal engineering curricula and the engineering degrees should be?

Then, there is another question. There has been a distinction for a considerable time between pure research and applied research. The sensible scientific men of pure research to whom I think I belong, do not recognize such a distinction between pure and applied research. There is no distinction in scientific research.

You may lay emphasis on development. We may lay emphasis on fundamental principals. It is all research of the same dignity and value. On that account the question has arisen as to whether when research is combined with advanced training for a profession, the practising profession, it would not be proper to have a single research degree to be all.

If your engineering degree is to be a professional degree and you want a separate research degree the question arises, Shall it be Doctor of Engineering or shall it be Doctor of Philosophy or of Science? Most of you do not favor the doctor of philosophy for engineering research. But after you reflect awhile you may not feel as antagonistic to it if you realize that this degree has come to stand for professional training in research in academic subjects. And see how it would simplify things, how it would give a national significance to the expression doctor, and how it would reduce the number of degrees.

Now, it is very nearly eleven o'clock, and while there are other important points that I would like to bring before you, I think you have probably grasped the spirit of the work that the Committee has undertaken, and for which it asks your coöperation.

As Chairman of the Committee of the Association of American Universities, I should very much like to have you appoint a coöperating committee, which would undertake a study of present conditions and present tendencies regarding engineering curricula and degrees because just as the Peace Conference was based on an inquiry made under the direction of Mr. House—I do not know how much it has been used—anything you want to propose must be based on present conditions. You must find out where you stand, what the nature of the flux is that is going on now, what the ideals are that you wish to reach, and then you will come to a common understanding.

. And just one word in conclusion. The Association of American Universities has I think been very useful in the development of the common ideals of the graduate school, for it started at a period of time when the graduate school was in its infancy. It adopted at once the principle, that, no action of the Association should be binding on the individual institution. The ideals were defined, discussed, and then the sentiment of the meeting tested by a vote, and it has been found that this sentiment has been far more binding than any definite resolutions that could be adopted.

I thank you.

Discussion.

The President: I did not know the specific things which Dean Leuschner would put before you, the specific statement, but I believed he would put before you a pretty clear and broad view of the case, and that the question would be put very clearly. Shall we have a committee on degrees for the coming year?

We have about four minutes before we must adjourn. Do you wish to discuss this paper?

Professor Park: May I ask Dean Leuschner if we can get copies of that report on degrees?

The President: The question is asked, Dean Leuschner, whether we may get out copies of that report on degrees.

Professor Leuschner Write to Dean Roble D. Salisbury (?), University of Chicago, who is now secretary of the Association of American Universities.

A. M. Greene, Jr.: Mr. President, in speaking regarding the paper by Dean Leuschner and also by our past president, I know that most people speak of trying out the five- and six-year course at present. Many of us fail to realize that a five-year course at least was tried many, many years ago at the University of Pennsylvania. I believe from the very conception of the Towne Scientific School in about the year 1876 the five-year principle was carried out.

The first two years of the course were devoted to cultural subjects, mathematics, language, history, science, followed by two years of science, with a slight amount of engineering, ending with the degree of bachelor of science. Then followed a postgraduate year, the fifth year so-called, in which the work was absolutely along one of the five lines of engineering.

The last class to follow that scheme was the Class of 1901, a four-year course having been organized in 1890 or 1893. I think it was 1890.

The success of the four-year course was merely an economic result. The students could not afford and would not afford the five-year course, and so the five-year course practically disappeared.

The five-year course is not a new thing. It is an old thing and well tried out, and it had many, many advantages. Men trained at first were trained along general lines and then along the specific lines of their own choice.

VOCATIONAL CORRELATION.

BY O. J. FERGUSON,

Acting Dean, Professor of Electrical Engineering, University of Nebraska.

Many studies have been made and figures tabulated showing the very serious replacement factor for labor in industrial organizations. Some large concerns have gone through the experience of having to hire during one year a number of workmen equal to the maximum number of employes engaged at any one time. Such a 100 per cent. turn over is woefully draining. It is extravagant. for it costs from a few dollars up to two or three hundred dollars to hire a new man, break him in, pay for his inefficient development period in spoiled work, slow production and interest on value of equipment tied up. We have recognized that the problems of "hiring-and-firing" are real and oftentimes vital. The drift of labor from job to job is appalling, and much has been said and done to relieve the situation.

There are striking parallels and contrasts between the case of the lobarer and the case of the college trained technical man. When the laborer becomes dissatisfied with his work he moves on to another place where he does the same kind of work. in the same way, or he may without very great effort change his occupation and do better or do worse. He will generally go adrift again. But the rut is deeper for the man who has painfully prepared himself to practice a profession, and even a mediocre success binds him to employment which he may never be able to do well. The laborer is restless, roving and desultorily ineffective; the professional man is lingering, stumbling and continuously impotent. Society suffers doubly in each case because of a piece of work poorly done, and because of a man not well employed. Although the professional man cannot be so easily tabulated as the drifter, his case is more serious than that of the laborer.

We have numerous examples of attempts made along different lines to aid men while in school to find themselves. Data are accumulating, from the colleges, from corporation schools and the industry, as well as from the United States Army. There must be a scientific study made of the results secured.

In order to do this, a definite program should be laid out by the Society for the Promotion of Engineering Education. A committee should be appointed to correlate the work and analyze the records of all parties concerned. It should go farther and suggest studies. Through this committee the society should proceed cautiously, but constructively, to determine—

(*a*) How far the essential qualifications for any kind of professional engineering employment can be recognized and tabulated;

(*b*) How far these qualifications may be discovered in trained individuals, other than by the long, trial process;

(*c*) How far the qualifications may be perceived in their embryonic stages;

(*d*) The most reliable and productive processes of testing and sorting men, and placing them;

(*e*) What time element is necessary to these determinations.

It is the province and duty of the S. P. E. E. to undertake a study of these stupendous problems of vocational allocation in the true spirit of research,—in fear and trembling, perhaps, as to immediate issue, but in hope and faith as to the sometime beneficial effect. We may expect results though we can never reach conclusions.

I, therefore, propose that the S. P. E. E. appoint a permanent Committee on Vocational Correlation (?) whose duty it will be to study, analytically and synthetically, the correlations existing among (1) men's natural aptitudes, (2) their developmental process and (3) their professional engineering careers,—having in mind the establishing of broad fundamentals in vocational guidance during formative periods.

HIGHWAY TRANSPORT ENGINEERING.

BY ARTHUR H. BLANCHARD,

President, National Highway Traffic Association.

The phenomenal development of highway transportation in the United States has created a demand for men having knowledge of and trained in a new technical field, which may be designated highway transport engineering. Fundamentally, this branch of engineering deals with the science, art, economics and business of highway transportation of passengers and commodities. In the opinion of some, highway transport may not be considered as belonging to the field of technical training and education. On sober thought, however, it will be seen that this branch of knowledge comes well within the classic definition of engineering embodied in the Royal Charter of the Institution of Civil Engineers of Great Britain, which, in part, is as follows: "The art of directing the great sources of power in nature for the use and convenience of man as the means of production and of traffic in states both for external and internal trade."

Before discussing the subjects which should be included in a technical course for highway transport engineers, a brief résumé of the development of motor transport and highway improvement in England and the United States will be presented in order to give some indication of the possible demand for men trained in highway transport engineering.

In England, the improvement of the main county roads preceded the development of highway transport. When transportation of heavy loads of commodities over highways was inaugurated prior to 1890, England did not have to wait for the construction of highway systems, with the result that rapid growth of highway transport took place. As early as 1891, Fletcher, an English author, in writing on "Transportation on Common Roads,'' considered some of the classes of highway transport now under discussion in the United States and cited many instances of conflict between highway authorities and highway transport interests regarding some of the fundamentals of highway design. The writer, while investigating highway transport in England in 1909 and 1910, encountered the same problems with reference to highway transportation and legislation that exist in this country today. In 1910, Henry B. Drowne and the writer prepared a paper on ''English and American Highway Traffic Regulations,'' in which the English traffic laws of 1896 and 1903 were referred to with special reference to weights, speeds and dimensions of motor vehicles and trailers. Pratt, in 1912, in his treatment of the subject of inland transport in England, presented many of the phases of the problem now confronting us with reference to what he called ''Back to the Land Movement.'' It is evident that a thorough study of English highway transport methods and legislation would be of material benefit to American engineers and traffic managers who are striving to develop efficient highway transportation.

During the past decade, the United States has witnessed a rapid growth in the utilization of the motor vehicle as indicated by a registration of 125,000 motor vehicles in 1908 and 6,146,617 in 1918. While in 1908, a motor truck was rarely seen on American highways, in 1918 not less than 600,000 were in use in the United States, motor trucks constituting from ten to twenty per cent. of the registered motor vehicles in the several States. Highway improvement has not kept pace with the increase in the utilization of motor vehicles. The fundamental basic axiom that economic highway transport is impossible without good roads should be fully recognized. A review of the present status of highway improvement in the United States indicates that there are about 2,500,000 miles of rural highways; that 12 per cent. are classified as improved; and that about one fourth of one per cent. are suitable for trunk highway motor truck traffic. Highway conditions will be materially improved during the next decade as is indicated by the 1919 appropriations of $500,000,000 for highway improvements and the widespread demand for the construction of a system of 50,000 miles of national highways by the federal government under the direction of a national highway commission.

The breadth of training for highway transport engineers should be far more comprehensive than has been considered necessary for many technical branches. Breadth of knowledge is essential from a utilitarian viewpoint, as the highway transport engineer must, in many fields, deal with social and economic conditions and must always have before him the fundamentals of sound business methods.

Comprehensive courses in highway transport engineering should include the following business and engineering subjects in addition to the usual fundamental humanistic, and pure and applied science courses contained in an engineering curriculum: Economics, political economy, social science, commercial geography, agricultural economics, business and contract law, scientific management, business organization and administration, cost accounting, interstate commerce, marketing and distributing systems, economics of railroad engineering, shop work on wood and metal, machine elements, mechanics of machinery, fundamentals of thermodynamics, gas and other engines, and electrical engineering, including ignition, starting and lighting.

The highway transport engineer or manager should have a knowledge of all of the following special subjects:

1. *Development and Economics of Highway Transport.*—History of American Transportation and Rural Development. English highway transport methods and legislation. Interrelationship of highway, railway and waterway transportation including: Influencing factors of distances, rates, kinds of freight, equipment. Port, terminal and warehouse facilities. Interrelationship of highway transport, good roads and rural development. "Back to the Farm" movement, which is a function of three fundamentals, namely, building of systems of good roads, utilization of highway transport,

and establishment of economic distribution from producer to consumer.

2. *American Highway Traffic Legislation.*—National, state, county, township and municipal laws, licenses, taxes and traffic regulations, especially those covering speeds, weights and dimensions of motor trucks, trailers and motor busses.

3. *Fundamentals of Highway Engineering Affecting Economic Highway Transport Including.*—Administration of highway departments; highway systems; traction and effects of different types of traffic on the several kinds of roads and pavements; location, drainage, foundations, grades, curves, widths and shoulders of highways as affecting economic highway transport; characteristics of different kinds of roadway with particular reference to traction; snow removal; guard rails, culverts and bridges; highway signs.

4. *American Highway Transport Methods.*—Comparison of horse and motor transport, municipal haulage, municipal delivery systems, store door delivery, inter-city haulage, long and short haulage outside of cities, rural motor express, return loads bureaus, motor truck parcel post, plant and factory haulage, army transport methods, horse transportation methods. Efficient methods of packing, handling, loading and unloading raw and manufactured materials. Highway transport management. Fundamentals of cost of highway transport, cost and record systems. Organization of motor haulage companies. Labor for highway transport.

5. *Transport Surveys,* being investigations of highway routes, highway transport legislation, traffic regulations, rural and urban transportation opportunities, competing carriers including railway, waterway and other highway transport facilities, and all other factors which may affect the transportation business which it is intended to establish.

6. *Motor Trucks, Motor-Buses, Tractors, and Trailers.*—Mechanism, operation, inspection, maintenance, repairs and cost data. Adaptability of different types of trucks and bodies. Disadvantages of overloading and overspeeding. Economic utilization of tractors and trailers. Garages. Acces-

sories, such as tires, fuels, lubricants and mechanical devices. The writer is of the opinion that automotive engineering subjects should be given through the medium of lecture laboratory and field courses.

Highway transport engineering courses may be offered by technical institutions by utilizing several educational agencies.

First, the courses may constitute third and fourth year options in the civil, mechanical or general engineering curriculum. The fundamentals of the special subjects outlined in paragraphs (1) to (6) may be given in six three-hour semester courses. A review of the curricula of the three engineering courses mentioned indicates that eighteen semester hours may be assigned in the third and fourth years to highway transport engineering without eliminating any fundamental engineering courses.

Second, a complete highway transport engineering curriculum may be arranged similar to the curricula of civil, mechanical and electrical engineering courses. Such a course should include all of the humanistic, pure and applied science, business, engineering and special courses previously enumerated. In this connection, it should be pointed out that a four-year course devoted to highway transport engineering and highway engineering would provide an admirable foundation for men entering either field of engineering. Broadly trained highway engineers should have, in addition to the training in the fundamental humanistic, scientific and technical courses, a knowledge of highway engineering, of the vehicles using highways, and of methods of highway transport.

Third, technical institutions may offer graduate engineering courses, which should be advanced specialized courses designed primarily for men who have taken a first degree in arts, science or engineering, who have acquired a knowledge of the fundamental principles upon which such advanced courses are based, and who have had a certain amount of experience in engineering work. It is evident that such courses should be given under such conditions that it will be practicable for engineers and others engaged in highway transport to take advantage of the opportunities offered. While the usual type of one-term or one-year graduate course may prove of value in some institutions, the writer is of the opinion, based on an experience with graduate courses for practicing engineers extending over a period of five years, that courses given in a concentrated form in short periods constitute the most efficient method of meeting the demand of practicing engineers for advanced technical training. As a definite indication of the demand for such courses, it is of interest to note that during a period of five years there were 229 registrations in the graduate course in highway engineering at Columbia University in which all subjects were given in periods of from two to three weeks.[1]

While advocating the introduction of undergraduate and graduate courses in highway transport engineering, the writer wishes to place himself on record as opposed to educational institutions offering such courses unless their financial resources are such that they can secure specialists to give such courses and provide the necessary laboratory and field equipment. Also it should be emphasized that duplication of specialized courses in institutions located in the same geographical section of the country should be avoided. If this recommendation was universally adopted, educational resources could be conserved with resulting economy and material increase in the efficiency of specialized courses. It is believed that the high cost of the necessities of life with the resulting demand that salaries of educators be materially increased will force many institutions to seriously review their educational programs and to determine the fields in which they can best serve their communities and most efficiently fulfill their mission in the nation's educational system.

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[1] For a further discussion of this subject, see the writer's paper entitled "Graduate Courses for Practicing Engineers," 1916 PROCEEDINGS, Society for the Promotion of Engineering Education.

THE VITALIZING PRINCIPLE IN EDUCATION.

EDWARD J. KUNZE,

Professor and Head, Dept. of Industrial Engineering, The Pennsylvania State College.

Were we to seek an answer to the question, what is the fundamental impelling force in intellectual advancement, we would doubtless find it in "man thinking," for man thinking is man progressing, man developing, man perfecting. The act of perfecting is primarily a volitional act. The question then resolves itself into, how may we best cause man to first conceive of the real value of this endowment and then to find continued delight in its exercise.

Engineering has long been known as an attractive subject. Engineering students usually work harder than those taking a general course of study such as one in the liberal arts especially when the latter is taken with no specific aim in view. Engineering students do not burn their books nor do they leave their lecture notes behind them when they are graduated from the college or university: There is a spirit of greater permanency surrounding their work. It appears that engineering teachers have, as a rule, rested on this important advantage over general courses of study. Engineers are not in the habit of analyzing their work as teachers in the same logical and scientific manner that they apply to their engineering problems: They are less rational and more empirical in their teaching methods. Dr. Mann* makes the statement that of the group of representative colleges investigated in his report, "38 per cent. of the professors spend no time at all in study to increase their understanding of educational methods." "only 2 per cent. spending more than 10 per cent. of their time in this manner." This condition is not strange when we realize that the engineer is not required to spend a single hour of special training for teaching in order to receive a teaching position. Most engineers assume the vocation of teaching either directly after graduation from a technical college or after spending a term of years in professional practice. Selections for directing positions are usually based solely on success in private practice. Frequently this very success draws attention and energy away from the work of teaching. Was it not Dr. Swain who first warned us that we must be first teachers and then engineers?

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* "A Study of Engineering Education," p. 101.

The sciences of education and of psychology are almost entirely devoted to the consideration of the child. Genetic psychology should certainly be studied by all who would profess a knowledge of these subjects but why stop with adolescence? Every college of education maintains a course in general methods. Why not offer, in some of these colleges, courses in which a critical study is made of laboratory methods in engineering and of similar subjects that are of direct interest to engineering teachers and in which actual and reliable tests could be made of different phases of engineering teaching and results arrived at in that scientific manner which becomes an engineer and thus enable the teaching engineer to secure a definite basis for his method of teaching. Especially well could this be done during the summer session. Dr. Mann has pointed out* the absolute necessity for the scientific construction of future engineering curricula. This opens a new and fruitful field for experimental psychology and experimental pedagogy and it is believed that soon some alert and progressive university will accept the opportunity usefulness in this line offers.

Whenever the shortcomings of our work in teaching engineering have been bared the concern seems to have been almost altogether with individual courses of study or with the teachers; too little concern, it seems to the speaker, has been evidenced with the student to determine how he functions or rather just why he does not function. Regarding students, Emerson says "we do not give them a training as if we believed in their noble nature." It is not sufficient to fill the student with facts nor is this primarily very important. Importance rests in the interconnection of facts. The student should add some of his own individuality to the world's stock of ideas. He should be led to make over what he hears and reads into a product of his own. It should become a part of himself. He does not really know a subject unless he can use it. He should be led to have opinions, to state them and to put them into action. We must develop the thought that is vague in the student's mind: The thought may be sure but it needs some nuture, some open channel for action. "The measure of the teacher's success," says Osborne. "is the degree in which ideas come, not from him but from his pupils." Dr. Swain in his excellent little treatise on "How to Study," addressed to the student. shows clearly that he had this idea in mind.

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* "A Study of Engineering Education," pp. 56 and 57.

We come back now to our original question: How may we secure "student-thinking"? It does not matter materially whether that thinking is done along one channel or another so long as it shall be "productive thinking" as Huxley puts it, or "inventive thinking" as Eliot expresses it. or as Professor Angel defines reasoning. "purposive thinking." The problem before us is to cause the student to acquire those faculties that permit him to examine data with discrimination and apprehend facts. to make precise comparisons and see existing relations. to draw accurate inferences and comprehend all the conditions involved. to exercise judgment and to solve problems. In order that he may do these things. we must first cause him to become interested in mental occupation in order that he may concentrate his attention. He must receive some motive power to cause him to acquire a degree of enthusiasm. We attend to that in which we are interested: that which has excited in us a motive for its consideration. All voluntary activities are directed toward some definite end, the attainment of which we consider of value. Long and hard consecutive thinking absolutely requires some personal initiative and there must be a motive for this compelling action of the will. Until thought is linked with purpose there is no intelligent accomplishment. The efferent processes must be developed; we have paid all attention to the afferent processes.

Formerly it was thought, and to a great extent the opinion is still maintained, that manual training derives its virtue directly from the motions made. It was said "the mind is taught through the hand" therefore it made little difference what sort of work was done so long as the motions were executed. While Comenius was the first to bring out the educational value of manual training, and Rousseau and Pestalozzi laid much stress upon providing this kind of exercise, Froebel was the first to indicate the true significance of manual occupations. He made practical applications of the view that the mind is "productive and creative." Children were expected to "think and do." We now understand that the virtue of the work is largely in retaining attention and in starting the thought process and therefore we must agree that the sort of work done has a vital influence on the establishment of the thought process. A healthy interest must therefore be aroused. Shakespeare has Lucentio say to Tranio "No profit grows where is no pleasure ta'en: In brief, Sir, study what you most affect," and in contemporary literature. Winston Churchill writes "the whole attitude toward life should be changed that life should appear a bright thing rather than a dark thing, that labour should be willing, vicarious, instead of forced and personal."

Interest is a function of the mind; its nature, as well as its intensity varies with the age, environment, and mental development of the person; its nature follows closely the order of development of the intellectual organism, *i. e.*, from the lower to the higher levels. The sensory areas of the brain function first, then the motor areas and lastly the higher levels which involve the reasoning powers. The development of the higher centers depends upon that of the lower. It is clear therefore that the nature of the stimulii that arouse interest in college students differs fundamentally and widely from that which similarly affects pupils of the high schools and grade schools. The interest that is desired for college men is not that which makes a subject entertaining but that which holds the student to his task until it is completed. Nothing is worth doing in mature life that is without details that are dull. In the latter sense, President Schurmann speaks of interest as the greatest word in education, and Dr. De Garmo says "The physical and mental satisfactions growing out of them (interests in problems of life) lend to labors that to us would be repulsive, a joy that makes even such a life worth living."

It has long been recognized in manual training that there is a natural tendency to seek repetition of those stimuli that give satisfaction to the organism. The satisfaction comes from the ability to do. It can be shown that a like satisfaction exists in repeating non-manual intellectual processes along lines familiar to the student. We are interested in what is familiar to us and find pleasure in perfecting our knowledge along such lines. Wagnerian music is not generally popular, but appreciation of it grows with repetition, and if one makes himself familiar with the drama and the motiva before hearing the opera it is appreciated much more. No man will have initiative in a certain line until he has some knowledge along that line. Therefore, to keep interest alive in any subject we must *develop the thought process from the familiar to the unknown.* We find here one factor in our vitalizing principle. It will be seen that we are reversing the usual process in that we first observe effect and then seek the cause: a deductive process. We are substituting an analytical for a synthetical method. This consideration sets up a "felt-need" as Dean Akeley calls it.* Recently Columbia University recognized this idea when the method of presenting the subject of history was entirely changed. Hereafter the history course at Columbia will start with contemporaneous history and the causes for the present state sought by going backward step by step. The tendency to-day is to study campaigns less and institutional, social, racial and economic causes and effects of wars more.

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* *Bul. S. P. E. E.*, December, 1916, p. 197.

The speaker has used this principle for a number of years in teaching machine design. The subject being considered from the point of view of stress applied, factors of safety allowed, etc., while, at the same time, the student was starting the study of applied mechanics. The theoretical reasons which were the basis for the formulæ used were more completely developed in the study of the applied mechanics. In a like manner the work in heat engines was developed.

The second factor follows logically. It has been the practice, in treating with technical subjects to present them first, theoretically and then give practical illustrations. It frequently happens under this procedure, that when the time for the application has arrived, the student has forgotten much of the underlying theory. This is due to the lack of connection in the learning process between the known and the unknown. A preliminary step has been used by the speaker which has proven to be a success. He presents technical subjects by *emphasis first upon their functional meaning, then by consideration of the underlying theory,* and finally by more complete and extensive applications of that theory. For example, in teaching the subject of heat engines; problems involving the construction and operation of steam engines, boilers, etc., are first considered, then the thermodynamics is given and finally such subjects as steam engine design and gas power engineering are taken up. In order to follow this method it is always necessary to rearrange the order of the subject matter as given in any textbook that is used in courses of this kind. This method has been used by the speaker for nine years. The same idea may be employed in other subjects such as machine design in which the subject would be treated first in an empirical manner. This idea is also the basis of the "case system" of studying law. In President Pritchett's introduction in Mann's report* commenting on the application of the "case system" he says: "It would lead the student from practical applications by analysis to a comprehension of theory, instead of from theory to applications as under present methods of teaching." Dr. Mann in this report commends very favorably the use of this idea as exemplified by Professor More. He says:[*] "The conventional course (in mechanics) begins with the statement of definitions and deduction of general principles, followed by the solution of typical problems. Professor More begins by asking the student, for example, to report on the safety of the sheet piling in a certain cofferdam whose dimensions and location are pictured and described. Theory and principles are worked out and proved as they are needed to solve the problem." He further states that the success of this "complete reversal of the conventional order" has caused the entire department of civil engineering to adopt its method.

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* "A Study of Engineering Education," p. vii.

The third factor involves *"complete learning,"*[†] that is, through mastery of the subject the first time it is taken up, at least from the one point of view. Experimental data shows this method of learning to be the most efficient. Productive work of any kind presupposes a certain mastery of the subject. This mastery of an elementary step not only increases the interest of the student but also increases his stock of ideas on that subject. This leads to production. Lack of thorough understanding of one step befogs and bewilders the mind of the student when the next step is taken up and leads to discouragement.

Professor Karapetoff[‡] has represented the last two factors in what he terms his "concentric method" in which he takes up a subject first in a very broad way, then he covers the same subject from a more and more restricted standpoint. In each step the learning is as complete as possible.

In order to make the learning process complete in each step, it is necessary to present concrete examples as soon as possible after principles have been enunciated. If one really understands a principle he can give at least an approximate physical meaning which bears on it. One does not really understand a principle unless he can use it; the limit of his knowledge is the limit to which he can apply it. The speaker once visited the class room of the head of the department of mathematics of a large university: After filling the blackboard full of "beautiful" mathematical demonstrations in calculus, the professor was asked by one of the students, "what do those final equations really represent?" The answer was "we will take up the applications later, I merely wished at this time to demonstrate the derivation." A golden opportunity to vitalize this work to the inquirer was lost! By the time the applications were considered the student had doubtless quite forgotten the "beauty" of the equations. Davis and Brenke,* on the other hand, show their appreciation of this factor in such illustrations as in their treatment of the logarithmic derivative by presentation as a relative rate of change of a quantity; they show its fundamental connection with the important "compound interest law." Dr. John Perry† was probably the first to strongly advocate the profuse presentation of practical problems as soon as the underlying theory had been developed, in order to fix the theory firmly and to make the higher mathematics an actual tool in the hands of the engineer. More recently Professor Karapetoff‡ recognizes that "interest is a paramount factor in education" and that "applications are always more interesting to the average student than a general theory." Not only should the example of the application quickly follow the presentation of the theory but the example should, in every case, be based upon the student's present or past experience. The employment of special instructors in English, mechanics, and other general subjects for engineering students is a step taken to bring about the employment of this factor. The construction, by the student, of simple models such as of paper to prove to himself that his development of intersecting solids was correct or of cardboard to prove a straight-line linkage, when made at once has a very vitalizing influence. In his address as retiring president of this society, Dr. Hayford favored consideration from a theoretical point of view first, and then the employment of applications, after which he recommended rapid alternations between the two. President Hayford's conclusions however, you will observe, were based on observation of mature and experienced engineers who needed no vitalizing factor to hold them to their tasks. They were absorbingly interested in their problem and needed no formal motivation. The material with which we have to deal in this paper is that which comes to us from the high school—the inexperienced student—the boy. After great interest has been established in any subject it is no longer necessary to follow the "functional first" method; at this time the presentation of concrete examples as quickly as possible after the theory has been deduced, greatly aids the learning process. Here the rapid alternations proposed by President Hayford will be found to be of much value.

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[*] A Study of Engineering Education," p. 58.

[†] "The Psychology of Learning," by Meumann, translated by Baird. Appleton, 1913.

[‡] Pro. S. P. E. E., Vol. XVI, 1908, p. 258.

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* "Calculus," Macmillan, 1915.

† "Calculus for Engineers," Longmans, 1897.

‡ "Engineering Applications for Higher Mathematics," Wiley, 1912.

Our next factor has reference to another division of the order of presentation of subjects. It is being recognized that grammar has been studied too early in our grade schools: It has been known that a very young child may very readily learn a foreign language or even two foreign languages at the same time but the mistake has been in considering language, and grammar, which is the science of language, as synonymous. We should *practice the art before we attempt the science* of a given subject. This increases interest in the subject and vitalizes the student's efforts. This principle is now being used in various departments of learning: Instead of beginning with a catalogue of the senses, psychology is now vitalized by a concrete consideration of the process of learning showing how the brain functions: Instead of first cataloguing stones and fossils and tabulating ancient periods, geology is now vitalized by consideration from the dynamic point of view; all persons are interested in knowing how mountains "grow": Instead of reciting Newton's three laws of motion as an introduction to physics, that subject is now vitalized by work done in the elementary physics laboratory by the student in which he performs experiments with perhaps crude apparatus that show him the soundness of these laws: Instead of studying history by rote, we now have it presented in narrative form; rather than cataloging dates of wars, the consideration of the policies and growth of nations is emphasized along lines that fit in well with the student's own experience. In this we may well follow nature and let growth supersede mind. We must grasp a subject before we can perfect it and hence art must precede science.

The next factor has reference to the *establishment of the real worth of effort.* The channel into which productive thinking flows is that which is pleasing to the student, that which appeals to him from the point of view of need and worth. Dr. Mann says:* "The probability of learning thoroughly, increases with the significance of the lesson." The speaker has employed this principle in the following manner: In his course, for example, in machine tool design let us assume that the problem is the design of a radial drill. His method is first to issue to the student, general specifications which are required to be supplemented by special specifications to be supplied by the student from various sources such as many catalogues and books. In the course of this procedure, the student, in time, usually finds himself desiring much detail information regarding the exact construction of the machine. An inspection trip to several factories is then made but nothing other than radial drills is investigated. The need has intensified the subject so that the student experiences a very efficient learning process and with the exercise of judgment, opportunity is afforded him to inject much of his own individuality in the design. A fuller explanation of the manner of employing this and other vitalizing principles has been offered by the speaker some time ago.* The speaker is one of those who has long advocated teaching modern methods of production and costs rather than merely turning out exercise pieces in the shops.† He has introduced the subject of works management in three different colleges. He has recommended not only the consideration of the cost of manufacture of the article made but also a comparison of the cost of the necessary machines and attachments in operating under widely varying conditions such as with an ordinary engine lathe and with an automatic machine.‡

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* "A Study of Engineering Education," p. 98.

The idea of presenting courses in general engineering rather than specialized courses was to overcome the objection to what was thought to be the narrowing influence of specialization. The fallacy here is due to the supposition that a broad education could be obtained by presenting many diversified subjects to the student. Instead of having a cultural value this method tends to produce satisfaction with a superficial knowledge of the subject. The student's field has been spread out so thin that there is no depth to his learning in any one line. This is far from a cultural attitude. The criterion, it appears to the speaker, is whether or not the course is merely informational or one dealing with fundamental principles. If the former, it should not be given; if the latter, the principles may be more forcefully brought out in a special subject which has in some way caught the student's fancy than in a subject which to him has no vital connection with his destiny. One may teach even a highly specialized subject in a liberal way and keep his students from becoming narrow minded. Broadness of spirit is by precept rather than by principle; by contact with liberal minds rather than by receiving college credits in a large variety of subjects especially when many subjects are studied at the same time. Culture is not obtained by securing college credits in certain courses; it is an inner attribute, an appreciation of great and good things, not a cataloging of them. Dr. Eliot says: "Education for efficiency must not be materialistic; it must be idealistic." Whether or not an occupation is materialistic or idealistic depends not upon the occupation but upon the spirit in which that occupation is performed. Culture is evidenced by a desire to perfect and to serve. To do anything well even though it may not be seen by the masses has cultural value. A mechanic in a shop, when he is not satisfied with his product unless all parts, including the hidden parts, have been properly made exhibits a cultural faculty that is far superior to that obtained after a term's textbook work in such subjects as ethics as frequently given. We have been devoting all attention to things, to curricula and not enough to the development of student attitude.

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* "Ideals and Methods of Machine Design and Construction at M. A. C.," *Bul. S. P. E. E.*, Vol. V, 1915.

† "Improvement in Shop Work Instruction," PRO. S. P. E. E., Vol. XVIII, 1910, p. 98.

‡ "Teaching of Scientific Management," PRO. S. P. E. E., Vol. XIX, 1912, pp. 106 and 112.

A student will grasp a subject more quickly if he sees clearly its requirement in the fulfillment of his destiny. He is not enamored of "padded courses." An M.E. student will not as a rule take kindly to a course in geology. Graphical statics for mechanical engineering students is best taught from the point of view of mechanism. There is practically no difference in the method employed to find the neutral axis of an irregular cross-section and that to solve a simple roof truss problem graphically but the idea of immediate worth vitalizes the subject to the student much better when it is presented as here indicated.

Another vitalizing principle is undoubtedly *Educational Orientation.* It is very important that each student should establish, as early as possible, a definite aim. Much of the bewilderment and discouragement of freshman and sophomores is due to lack of definite aim. It has been pointed out* that this is one of the principal causes of the so-called "sag of the second year." Dr. Mann recommends orientation during the first two years.*

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* "A Study of Engineering Education," p. 58.

One advantage of specialization is definiteness of aim. It matters little which particular course a student may elect; added interest is secured and tendency for greater application on the part of the student is developed if he recognizes a definite end. There is no great loss if a student should change his course; much has been studied in common in all engineering courses.

The speaker has employed orientation for freshmen by giving a series of lectures, first, treating of the aims, attitude and training of the engineer and of methods of engineering practice. The historical development of the engineering profession was then taken up. The latter part of the course was divided among the four departments of engineering. In his own, the speaker presented the various lines of work carried on by the mechanical engineer such as gas power engineering, works management, refrigeration, etc., giving in each case the historical development of that particular subject, then its field, trend and applications. At this time shop and plant visits add greatly to the vitalizing process.

Our next vitalizing factor has to do with *taxing the capacity of the student at each stage*. The proper grade of work should be given a student; if he is assigned lower grade work, intensity of effort will suffer. Students as a rule desire to do important work; performing detail work when they should and are able to do design work reduces the amount of ground a student may cover in his course.

As a rule, courses in engineering contain little or no engineering subjects during the first two years. This causes lack of interest. It is not only possible to teach some real engineering during these years but it is expedient to do so. Kinematics may be given very early. In one college with which the speaker was connected he was responsible for pushing the kinematic course forward a year and a third in the course. Kinematics may be given in such a way that the student will not fail to see its engineering relation and also so as to develop his ingenuity and power of analysis. In assigning problems in this work the speaker has found it very profitable to have the different students each have a distinct problem in which one factor is varied for several cases. The different solutions are then brought before the class as a whole enabling them to receive the benefit at times of a considerable amount of investigation. In mechanical drawing, pumps, engines, etc., may be taken apart and used as models. This not only better acquaints the student with the construction but also provides a very wholesome laboratory exercise early in the course. The speaker has used this method with decided success in a class numbering as many as forty-six students. It is believed that a school-boy atmosphere may be discouraged and real business methods encouraged by adopting regular drafting-room standards and methods at once with freshmen. Therefore the speaker adopts large size sheets for freshmen and also advocates teaching them to ink at once on tracing cloth instead of going through the preliminary stage of inking on paper.

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* "A Study of Engineering Education," p. 88.

In teaching machine design, the speaker has employed this factor* by having seniors and juniors design machinery which was afterward actually built and sophomores lay out the details; the tracing being done mostly by freshmen. This follows the order obtaining in a commercial drafting room and enables each student to do that grade of work and only that grade which calls forth intensive effort for that grade of student and at the same time that grade which their several abilities enable them to perform.

Our next factor has reference to the *length of task and method of presenting subjects.* If an assignment be so long as to permit of only partial solution the student is likely to be-

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*"Ideals and Methods of Machine Design," *Bul. S. P. E. E.*, Vol. V, 1915, p. 43.

come discouraged or to obtain solution by means other than by individual work and this injures rather than helps him. In the earlier work in the mechanical laboratory, the speaker believes instruction should be quite definite in order that the student may acquire proper habits of conduct at once. He therefore has required preliminary reports, which afterward became part of the final reports, to be turned in. He also made a practice of discussing briefly the plan of operation and object of an experiment in the laboratory just before the experiment was to be performed.* This has the advantage of giving to all participants, a perspective of the entire problem. In order to eliminate waning interest due to meeting obstacles without sufficient time or opportunity to seek references, computation periods are recommended, providing time and facilities such as reference books, also supervision, in order to help a student over the "high points." This latter has the further advantage that it eliminates the evil of having a few men do the actual computation while the others copy the results.

The evil of having too great a requirement for outside preparation in one or more subjects should be eliminated by proper faculty action but such elimination requires a use of more definite standards of measurement than now prevails; it also calls for regular engineering faculty meetings, a condition rarely found where too much outside professional practice, lack of fundamental educational knowledge, or other similar bars to efficient instruction exist. In assigning credits for courses, the actual requirement of time including all necessary preparation and outside work should be considered.

The present tendency is to reduce the number of required credits. Dr. Mann advises that they should be less than eighteen.† Earlier in the year, the speaker outlined a course in mechanical engineering for Cooper Union. He found in one case twenty-two credits were being carried at one time.

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* "Improvement of Laboratory Instruction," *Bul. S. P. E. E.*, June, 1911, p. 613.

† "A Study of Engineering Education," p. 87.

In his proposed curriculum* the number ranged from $15\frac{2}{3}$ to $18\frac{2}{3}$, the latter occurring however in only one semester; one other semester alone had as many as 18 credits. Likewise if the number of subjects studied at any one time is great the subjects will be stretched out so much as to cause a break in transition and hence loss in continuity. In the former Cooper course eleven subjects were given during each of the second and third years and twelve during the fourth. The proposed schedule as submitted by the speaker reduced the number of subjects carried at any one time to from four to six except in one case in which there were seven subjects but in this case several of the subjects were closely allied to one another such as "materials of machines," "applied mechanics," "machine design," and "material testing laboratory." Dr. Mann recommends† that the subjects carried at any one time should not exceed five.

Without perfect transition the thought development in any given subject is impaired. This therefore requires that courses be carefully correlated. Each subject should be definitely placed in the course. Its position should be based not alone on what may seem to be its logical setting, but based rather on psychological and pedagogical considerations.

If the order of instruction in shopwork and of vacation work were carried out along the lines of a former suggestion of the speaker‡ and also embodied in the Cooper report, the instruction in the machine shop would assist the student in his mechanical drawing and prepare him to do machine-shop work in a commercial shop during the first vacation. This would aid him in his sophomore work in empirical machine design and in kinematics and this latter work would prepare him to do detail work in a commercial drafting room during the second summer. Experience in the latter would excite a desire to do real design work on the part of the student and would also increase the students' stock of ideas along this line so that in his junior year he will be ready to study machine design and applied mechanics. During this year he will study heat-power engineering and become acquainted with power-plant apparatus and the operation of power-plant machinery in the laboratory. He will thus be prepared for his third vacation work, which would be in a power plant. Work in such a plant would directly prepare the student for the study of power-plant design and would arouse his desire to take up steam-engine design, gas-power engineering, etc. Similar other transitions and correlations should be provided for in a properly outlined course.

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* Report on Mechanical Engineering Course, submitted to Director Richards, Cooper Union, January 27, 1919.

† "A Study of Engineering Education," p. 87.

‡ "Improvement in Shop Work Instruction," PRO. S. P. E. E., Vol. XVIII, 1910, p. 98 and "Organization of Vacation Work," PRO. S. P. E. E., Vol. XVIII, 1910, p. 126.

Another vitalizing principle is that which establishes *permanency of subject matter* by securing retention of matter once learned by subsequent required use, requiring a degree of proficiency at all times. This factor savors much of a "big stick" incentive since there is an apparent penalty attached to lack of compliance to its terms. The spirit of "passing off" a subject should not be tolerated. It should be assumed that a subject is never to be dropped. One way to accomplish this effect is to call for complete applications of specific problems in which all information is coördinated in a single practical problem. This idea is used in such subjects as advanced machine design and drafting in which empirical design, kinematics, materials of machines, applied mechanics, specifications and even costs and methods of production are required to be combined in one problem. This idea may likewise be employed in power-plant design. The speaker has long advocated that after a thorough year's work in English, topics be assigned to students regularly throughout the remaining years; these topics to be part of the regular work of the particular course under which it falls and the matter turned in, whether laboratory report, essay, letter, specification or what not, be checked first for technical content by the technical department and then turned over to the English department for grading. Likewise the reading of one or two volumes of good literature could be required of each student each summer and examinations held in the fall on the substance of the assignments but not on the philological construction. It should be required of every student that he keep up his grade in this subject at all times. Likewise a modern language would become a tool instead of a relic, if after one solid year of study, technical literature, such as a monthly periodical, were read and articles of immediate worth and interest were discussed in a class held each week throughout the remaining years by engineering teachers.

The most interesting application of this principle is that carried out in that excellent organization in the University of Cincinnati, where no student is finally passed in any subject until he graduates, and where a student although he may have received a passing mark at the completion of a certain course may be "flunked" by a professor who is offering a course in which the former subject is required; that is, the professor of machine design may "flunk" a student in calculus if he finds the student deficient in his present knowledge of the calculus.

We come now to a very important vitalizing factor, the *development of judgment.* Elsewhere* the speaker has indicated a method of teaching judgment. The first essential is accurate perception: The student must be taught to distinguish between the similar and the same and this attitude is aroused only when the student is interested in the subject and has already some fundamental knowledge of it. As in the case of the delight experienced in repeating sensori-motor coördinations that have been acquired, so also, one finds delight in exercising judgment on matters with which he is familiar, and judgment is the forerunner of the inventive faculty, that most valuable asset to the engineer. All of the forementioned factors contribute to this one and in return it reacts upon many of them.

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* Pro. S. P. E. E., Vol. XVIII, 1910, p. 379.

Our last factor is the *development of individuality.* After training a student carefully during the earlier stages of his course in habits of procedure he should be more and more relieved of the more or less didatic influence and allowed freer exercise of his own mind. He should be given problems that challenge his ingenuity and thus foster creative work. He should be allowed more and more to add of himself to such problems as involve design, experiment and specifications but he should at all times be required to state the reasons for his conclusions.

It may be well to cite a few examples of applications of above-named factors in which more than one factor is involved. In the teaching of English to engineers the primary objects sought are: the attainment of self-expression, both oral and written and the creation of an appreciation of good literature. The first is best accomplished by the consideration of subjects that are of vital and immediate interest to the student and the best method to attain this end is through the service of an alert man who can be in sympathy with engineering work. The second is best attained through the efforts of a good reader who would lay most stress on the thoughts that are expressed by the author studied rather than on the "anatomy" of the essay, narrative or descriptive. In the former, precise and forceful expression is sought. If the student really has something vital to say it is not difficult to teach him to deliver it: The essential thing is that he is caused to develop proper habits of clear thinking. For "cultural" reasons "thin courses" in English are frequently distributed throughout all four years of the college course; pedagogically this method is wrong. A solid course given in the first year, followed by an enforced constant self-correction in English due to the possible "flunking" during the later years, it appears, would be much more efficacious.

The subject of works management, touching as it does such humanistic subjects as economics, psychology, sociology, ethics, and even history from its economic consideration becomes a potent agent for cultural development and if it is properly taught will assume an importance entirely apart from the fact of its connection with this great era of modern production. A class of students can not but be benefited by such discussions as "the effect of decreasing the humidity on the production of labor," "the psychology of the bonus envelope," "industrial betterment" and many other similar topics.

Contracts and specifications is usually taught by the civil engineering department and its consideration therefore is largely from the point of view of "cut and fill" and similar problems. The speaker believes that mainly for vitalizing reasons, "specifications" should be employed in several courses such as in machine-tool design, engine design and power-plant design before it is studied from an analytical point of view. He believes it to be far better to give a course in engineering law during the last semester and in this take up much more than merely contracts and specifications. There should be no need for a special course in business letter writing. If the elements of this subject are studied in the first year and the student required to write business letters periodically, such as letters of transmittal in specifications, no difficulty would be experienced in securing good results but such a condition can only be hoped for in colleges in which the organization is very strong.

It will be observed that in the suggestions made, memory subjects have been recommended to be given early in the course while those subjects which require more mature judgment are recommended for the later years. The study of economics, of engineering law, and of works management in the last year prepares the student, in a wholesome way, for his absorption in the industries after graduation.

Summarizing, we find the factors that make up the vitalizing principle in education as enumerated, to be:

1. Development from the familiar to the unknown.

2. Presentation of functional consideration before theoretical.
3. Securing complete learning at each stage.
4. Presentation of the Art before the Science of a subject.
5. Establishment of real worth of effort.
6. Introduction of educational orientation.
7. Taxing the capacity and ingenuity of the student at each stage.
8. Controlling the extent and correlation of tasks and their particular setting in the general scheme.
9. Securing permanency of matter once learned by requiring regularly its subsequent use.
10. Developing judgment.
11. Developing individuality.

The speaker is fully aware of the many difficulties that may be encountered in the employment of the factors described due to peculiar administration, to conservatism, to geographical location, and to size of college, but he believes it proper to set down the ideals sought and then to approach those ideals as closely as may be.

The factors mentioned are doubtless not all of the vitalizing factors and the speaker realizes that much has to do with the personal equation of the teacher but he believes that when the factors enumerated are all regarded, not only will the educational content of the student be increased but his stock of ideas also will acquire momentum and each subject studied will become to him a living thing.

THE VISUAL INDUSTRIAL COURSE, INC.

BY COLLINS P. BLISS,

New York University.

The war work in our various universities and particularly in those schools in which vocational classes were held before the existence of the S. A. T. C., has accomplished two important results. First, it has clearly demonstrated what can be done by intensive work and secondly, it has emphasized the need of a closer coöperation between the industries of the country and our technical schools, to the end that no useless training be given.

In all of our war efforts results alone counted. The thing that couldn't be done, had to be done *and was done,* and not alone that, but the training each student was to obtain, as in the vocational courses, must be completed within a definite time limit.

Now, the application I want to make of this is that there are many ways in which we can intensify our work and gain some time, even in the four year course, for the introduction of business and economic subjects so fully discussed at the recent conference in Washington. One of these ways I will allude to in a moment, but has there always been between the various departments or even between those giving each particular course, the kind of coöperation that would insure absolutely that the same subject matter in one course is not covered by any other? Many of us have found evidences of duplication altogether too frequently.

In our vocational work for the War Department this particular thing was guarded against; each course gave the kind of training that it was intended to give.

I firmly believe that these intensive methods can be applied to the subject matter of many of our courses,—not alone engineering,—but also to those so-called cultural and pure science subjects, where sometimes mental gymnastics are considered a more useful training than providing a student with the tools for doing an engineering job, not only after he graduates, but even during his college career—in the later years before graduation.

If the promises of industrial activity in this country for the next decade hold good, it behooves those connected with the training of the coming engineer to read rightly the signs of the times and *prepare the product for the market.*

No business enterprise would consider for a moment the production of an article, beautifully made, thoroughly finished in all its parts, accurately fitted in every detail, without first having decided what the market demanded or could absorb in this particular line.

Technical schools at the present time are very much alive to the fact that conditions are considerably different from those extant five or six years ago. We are asked to produce a product for a market which has become overwhelmingly industrial and in turning out the engineers of the future, we must also train along broader business and commercial lines.

Industries know a great deal more about the product of the universities, than either the universities or their product know about the industries—largely because the latter use the University product and soon learn its possibilities and limitations.

It would be utterly impossible for any university to attempt courses of instruction in the usual manner, which would acquaint students with the details of any industrial operation. Our different technical schools, wherever practical, have relied on shop visits and factory inspection trips, which are admittedly of considerable value, even at the cost of a great deal of time and also in these days of high railroad rates, much money. These visits are welcomed by the university teacher, the student, and the industry. As a matter of fact the complaint of the industry is that our students do not learn enough about modern industrial operations to permit them to get the best out of all of the training received at the technical schools.

In the early months of this year a group of university men, interested in industrial relations, perfected a plan for filming all the basic and essential industries of this country. An organization known as the Visual Industrial Course, was incorporated and with it was associated a corporation which for years has produced all Pathé educational and industrial films.

The object of the Visual Industrial Course is to provide a service for the universities and technical schools of this country and Canada, whereby all the methods, processes and products of the twenty-five to thirty basic and essential industries can be brought into the classroom through *motion pictures, slides and industrial manuals.*

There are in existence many so-called ''educational films'' produced by our large industries for advertising and other purposes and also by governmental bureaus. A great deal of the material in these negatives, from which positive prints can be taken, will be worked into the films for classroom use, but there is a vast amount that will be of no use whatever for the purposes of the Visual Industrial Course.

In producing the pictures, along with the camera experts will be associated an expert in each industry filmed and a university professor competent to superintend the taking of those things which will be of value to the student from a professional standpoint.

These two men will collect all the needed data to give a complete history of the industry filmed, from its inception through all its development to the various products manufactured into as many fields of activity as this may lead. This will include, wherever possible, information regarding management and economic problems met and solved by the particular industry under discussion.

All of this material will be collected and edited for publication in industrial manuals to go with the films for use both by the professor showing the films and slides and by the student taking the course. These manuals will form a library for the student which he will take with him, when he leaves college and which will give him a ready reference concerning the conduct of any industry upon which he desires to refresh his memory.

A staff of associated editors is now being organized from among our leading universities and about thirty have heartily endorsed the plan and consented to serve.

As an initial supervisory or consulting board, the following men, prominent in educational and industrial lines are associated with the course: Mr. C. M. Schwab, Mr. Finley J. Shepard, Mr. William R. Malone, president of the Postal Life Insurance Company, Mr. Alexander Lyman, general attorney, New York Central Railroad, and Dr. Steinmetz, of the General Electric Company.

As many of us know who have had any experience in producing moving pictures, the cost is enormous and far beyond what any university would be warranted in spending to produce and own any set of films of this nature.

The Visual Industrial Course, therefore, becomes a centralized clearing house for all our technical schools and provides the service whereby every known industrial process can be brought directly into the classroom and studied to any extent, whether that be much or little.

All material passing through this clearing house will be assembled as a "Course" and it has been estimated that to cover the entire series to be produced by the "Visual Industrial Course" will require the equivalent time of a two-hour subject throughout one college year.

Several of the universities have already arranged to do this in the freshman year, under various captions—New York University, for example, under "General Engineering Practice," The University of Washington, Carnegie Institute of Technology, the University of Cincinnati and many others are making arrangements to include the course in the college curriculum.

It is felt that a general training course of this kind may materially assist an entering student to a better knowledge of the engineering profession as a whole and perhaps enable him to decide on the kind of engineering in which he is most interested. If this alone can be accomplished and *engineering misfits* avoided, it is easily worth all the effort and expense involved.

It must be said in passing that the "visual course" will cover construction and civil engineering problems and processes, as well as mechanical and chemical.

Several of those technical schools already approached desire special reels for use in courses in other years. than the freshman. With the mass of negatives which will be obtained, excerpts can be made producing a reel of 1,000 feet or so which in fifteen minutes will tell the story of an hour's oral instruction from text-book or by lecture.

Many of our largest industries are already considering coöperation to a greater or lesser extent. In a few instances, it will be desirable to have one concern represent one entire basic industry; in other cases several units will be needed in producing what is desired.

It is estimated that it will take three years to obtain all the material, and while the date for beginning regular service cannot be definitely promised, it is hoped that the Visual Industrial Course can give service of a limited nature before the end of this year.

There is perhaps a question in the minds of some as to the cost of this service—the Visual Industrial Course. That, gentlemen, is almost unanswerable at the present time—not because of the great production cost, but due to the fact that it is the aim of the men behind the plan to give the material to the universities and technical schools of the country at the least expense consistent with a rather exacting service.

There are of course many interesting details to a project which promises to be of material assistance at a time when the training in our technical schools is bound to be affected more than ever by industrial relations and therefore we may all expect to hear more about it in the near future.

THE EFFECT OF THE WAR UPON ENGINEERING EDUCATION IN THE UNITED STATES.

BY ANSON MARSTON.

Engineer Troops in the War.

The first effect of the Great War upon engineering education in the United States was to begin sweeping away into the Army a large proportion of the students and faculty. Within a year and a half we increased our engineer troops from a handful to over 300,000, serving under 15,000 engineer officers, and probably constituting the greatest engineer force in all the history of armies. In addition, thousands of engineers served in the Chemical Warfare Section, in the Tank Service, in Aviation, as Quartermaster's Engineers, in the Infantry, in Ordnance and especially in the Artillery.

From the very first the great danger of an impending shortage of engineers in consequence of the war was foreseen, and the Chief of Engineers addressed this society in 1917 to urge that the engineering colleges continue the training of future engineers in four-year courses.

Government War Time Demands on the Engineering Colleges.

As the war went on, however, the government made ever greater demands upon the educational institutions of the country for temporary special service to meet immediate military exigencies. First, large detachments of soldiers were sent to the engineering schools for short course, intensive, mechanical training (the so-called "Class B" work), with highly successful results. Finally, in the fall of 1918 the government practically took possession of the higher educational institutions of the country, including the engineering schools, for the S. A. T. C. work. The organization of the S. A. T. C. directed a very large number of young men into engineering courses who would have chosen other lines in peace time.

We are all familiar with the brief but lurid career of the S. A. T. C. The entire lack of acquaintanceship of educators with military customs and of military officers with educational customs, the great and terribly fatal influenza epidemic in October and the unexpected collapse of the war early in November, with the accompanying demoralization of demobilization—all these combined to make S. A. T. C. success hopeless. Yet the writer believes that the plan would have succeeded if the war had lasted a year longer.

As a soldier who served nearly a year and a half in the army and who has not yet succeeded in untying red tape enough to get his $60 bonus, the writer cannot help expressing a feeling of dissatisfaction with some (not all) S. A. T. C. students—those who became students partly to keep out of the fighting ranks till the last possible moment, whose educational expenses (including board and clothes) were borne by the government, who received the same pay as real soldiers and the same bonus at the close of the war as men who fought in France, who, nevertheless, complained at every little inconvenience like spoiled children and who showed insubordination at times which would have been visited with dire punishment in an army camp.

However, the S. A. T. C. caused at least two good effects on engineering education:

(*a*) It left at the end of the war a large number of young men in the engineering freshman classes, which otherwise might have been almost empty.

(*b*) It almost completely broke up all standardized (some of them fossilized) traditions and customs in the engineering schools, thereby providing a great opportunity for radical improvements, otherwise impossible, in engineering education.

PRESENT GOVERNMENT WAR DEMANDS UPON ENGINEERING COLLEGES.

Government war demands upon our engineering schools have not yet ceased.

A. Already some 300 wounded soldiers have been assigned to the Iowa State College for educational rehabilitation work, and a government agent who visited us a few days ago estimates the total number which they would like to send us at 700 to 1,000. About 10 per cent. of those so far assigned are collegiate students. About 35 per cent. to 40 per cent. of the total are assigned for engineering collegiate and non-collegiate work. Thus we face the question of whether we are willing to accept some 300 non-collegiate students for two-year trade school vocational work along mechanical lines. It may be added that we estimate that 15 per cent. to 20 per cent. of the non-collegiate soldier students are planning or will come to plan to complete the college entrance requirements and then enter regular four-year collegiate engineering courses. I am informed that some universities are opening their doors for the first time to non-collegiate students in order to accept these wounded soldiers.

B. The development of the R. O. T. C. as a part of the permanent military policy of the country brings many engineering colleges (perhaps especially those at land grant institutions) face to face with important and perplexing questions. At the Iowa State College we are organizing infantry, engineer and field artillery units and expect to have a cavalry unit. We have been urged to establish coast artillery, signal corps and motor transport corps units, all of which would draw exclusively upon our engineering students.

I may add that we have about twelve army officers assigned to us, that we are starting to build a large armory for which the money was appropriated in 1917, that the government will keep several hundred thousand dollars worth of equipment at our institution for which we must provide housing (including stabling for cavalry and artillery horses) and that accommodations must be provided for some enlisted personnel.

In view of the present uncertainty as to the future military policy of the United States we feel that we must move slowly in establishing more than the four units already determined upon.

Service in the summer training camps will have an important bearing upon the summer professional work of our engineering students, which we feel is of great value in their engineering training.

Through the Commissioner of Education the U. S. Government is now calling upon the engineering colleges to introduce business training for engineers as required work into all our engineering curricula. Already three conferences on commercial engineering training have been held under government auspices—in St. Louis, February 22, 1919, in Washington, March 31—April 2, 1919, and again in Washington, June 23 and 24, 1919. The government's call for commercial engineering training is made because of the national need for engineer leaders who can develop and direct our great mechanic arts industries and our domestic and foreign trade in their products. The writer believes that at least ten semester credit hours instruction in simple, fundamental business principles ought to be introduced as required work into every engineering course and treated as just as fundamental for engineers as instruction in chemistry and physics. Furthermore, elective groups in commercial engineering ought to be provided in the junior or senior years whereby engineering students who desire can obtain more intensive and advanced business training.

Are not the present government calls upon the engineering schools in connection with wounded soldier vocational training, R. O. T. C. training and commercial engineering training significant indications that an era is immediately ahead in which we are to have more systematic coördination of all our engineering educational work to meet national needs as outlined by government agencies? For example, highway construction looms up in the immediate future as one of the greatest impending engineering developments in the United States. Why should not the national government interest itself in securing adequate instruction in highway engineering as well as in commercial engineering in our engineering schools.

Engineering research is exceedingly important from the national standpoint. Two bills are now before Congress to establish an engineering experiment station in each state. The National Research Council is a comparatively new government agency, created during the world war, which ought to come into active touch with all the engineering schools.

Possible Improvements in Engineering Education in Reorganizing After the War.

The writer has already stated that the war has broken up the regular work and customs at our engineering colleges to such an extent as to afford a great opportunity to effect radical improvements in engineering education. Only time can tell just what will come from this opportunity. Great changes may be effected or the engineering schools may drop back into the old ruts.

The engineering schools necessarily move slowly in adopting radical changes. General Black has so much authority over the Corps of Engineers that he can decide by fiat that the ''case method'' of instruction shall be adopted in the engineer school at Camp Humphreys. An engineering dean has no such authority. He must convince not only his faculty but his president, and through his president the board of regents before the change can be brought about. And woe to the plan if it involves additional expense.

On the other hand, General Black's plan for the engineer school might be dropped entirely next December when he retires from the Army if the new chief of engineers should happen to hold different views, while progress at engineering colleges is much more immune to vagaries of deans.

The writer thinks that engineering educators must admit that dissatisfaction has been growing up for years among practicing engineers and among engineer employers with the results of the work of the engineering schools. True the criticism, while well meaning, has not been any too intelligent as to practicable remedies. Nevertheless, we should not overlook it complacently. We should study the whole situation most earnestly at this present time, with absolutely open minds.

The writer believes most earnestly that what was good enough in the past is not good enough for the training of the engineer for the great future which ought to be his without fail.

The writer will indicate some improvements in engineering education which he believes ought seriously to be considered for the immediate future.

1. *Commercial Engineering Training* should be introduced into all engineering courses as fundamental required work, as already indicated.

2. *Military Training.*—Engineering students ought to have the opportunity while in the engineering schools to do whatever military training Congress may decide is needed to make reasonable advance provision to meet the government's need for engineers in time of war.

3. *Engineering Research.*—The engineering schools ought to make themselves important factors in engineering research and ought to coördinate in a national organization of engineering research to meet national needs.

4. *Graduate Engineering Work* ought to be developed extensively on a systematic general plan which would avoid unnecessary duplication at neighboring colleges. Research and teaching fellowships should be established generously.

5. *Salaries of Engineering Professors Ought to be Raised.* —All prices are now on an extremely high level, and many thinkers believe that the world's prices will be much higher permanently in the future than in the past. A great shortage of engineers is now adding strength to meritorious organized efforts of engineers to put engineering remuneration on a fairer basis in comparison with bricklayers, carpenters and locomotive engineers. The engineering schools must compete in open market with employers of practicing engineers. The

writer believes that salaries of engineering professors ought to be 50 per cent. to 100 per cent. higher than the average in 1916, provided that engineering professors are held to merit and to time requirements in their daily work as strictly as if working for outside employers.

6. *Definite Plans for Faculty Study and Training* ought to be put in force. Graduate work by instructors and assistant professors (at least) ought to be made prerequisite to promotion. Associate professors and professors ought to be given compulsory leaves of absence every few years (on part pay) to improve their qualifications by actual engineering practice. There ought to be an absolutely open season for engineering deans at all times, with both spring and fall shooting open to all ambitious and energetic professors. Training classes in teaching methods are desirable. Every member of an engineering faculty ought to be rated numerically from time to time by his superior officers, taking into account his manhood qualifications, his professional qualifications and his success as a teacher, and all promotion should be for merit alone.

7. *Engineering Classes Should not be Turned Over to Cheap, Inexperienced Instructors.*—Only mature engineers, well qualified as engineers by outside experience as well as by college training should be given charge of classes. The students are entitled to the inspiration and to the professional instruction outside of all text-books which can be obtained only by direct personal contact with high class engineer professors throughout the entire four years of their college life. The cheap type of men often employed as instructors should be used only as assistants in preparing class material, in directing minor details of laboratory work and in correcting student drawings and papers.

8. *No Engineering Class Section Should Include more than Fifteen Members.*—Each engineering class should be so small that the professor can call readily upon every student to participate in every class discussion. Each professor should have direct personal contact with every student in each class at every recitation or laboratory period.

9. *Better Liaison* should be established between engineering departments and between the engineering college and those departments of other colleges which instruct engineering students. "Liaison groups" or committees, made up of representatives of all interested departments, should be constantly at work on the content and methods of instruction of the work in each subject in order to secure the utmost efficiency. The instruction in mathematics, chemistry and physics should be adapted to engineer needs, and conversely engineering professors should use the latest and best mathematical, chemical and physics ideas and methods in their engineering classes.

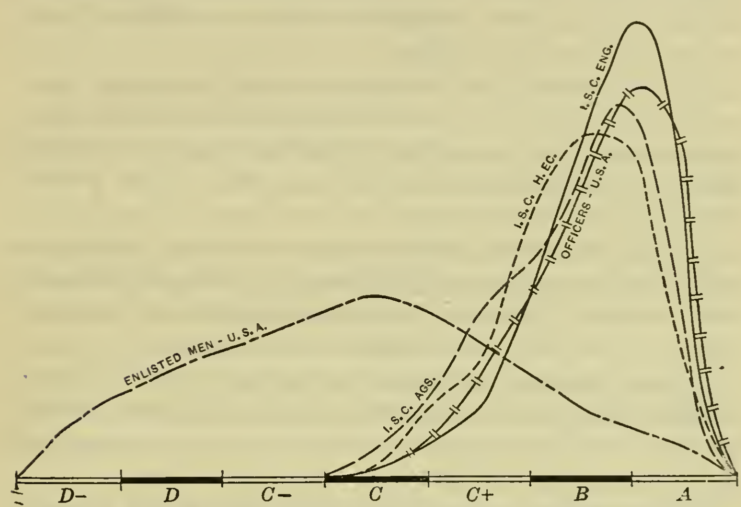

FIG. 1. Distribution of Intelligence Ratings. Comparison of College Students with Army Groups. Officers Curve by Scaling from Report on Army Mental Test printed November 22, 1918.

‖—‖—‖—‖—‖	Officers U. S. A.	8,819
—·—·—·—	Enlisted Men U. S. A.	1,500,000
————————	I. S. C. Eng.	208
— — — — —	I. S. C. Ag.	103
- - - - - - - - -	I. S. C. H. Ec.	160

10. *Intelligence and Vocational Tests* should be applied to all engineering students.

For the present such tests should be applied as educational research in order to compare the results with attainment in classes and in professional engineering work, in the hope that reliable tests and standards may result.

The writer presents a diagram showing the results obtained by applying the army intelligence tests to the 1918–19 freshmen at the Iowa State College.

(*a*) The curves for all courses show that the college freshmen rates mentally very far above the average man. the newspaper humorist to the contrary notwithstanding. The college freshman rates on a par with the army officer of the present war as to intelligence capacity.

(*b*) The engineering freshman passed the army intelligence test somewhat more successfully than his brothers or sisters in other courses. This superiority did not show in the arithmetical test but did in the number relation tests.

(*c*) It is proposed to compare individual results in the intelligence test with actual attainments in classes and in outside work and quite possibly new intelligence tests should be devised for college students.

11. *Rating Tests.*—Every student should be rated by every instructor under whom he takes work as to general qualifications as well as class attainments. Dr. Mann devised a rating before the war which gave 75 per cent. weight to manhood qualifications and only 25 per cent. to professional training and experience, basing these figures on numerical tabulations of answers by engineers to a questionnaire. The writer believes that the rating test used for army officers during the war is better. It is as follows:

	Per Cent.	Per Cent.
Physical qualifications	15	
Intelligence qualifications	15	
Leadership qualifications	15	
Personal qualifications	15	
Total manhood qualifications		60
Professional training and experience		40
		100

Quite possibly a still better rating standard might be devised for engineers. No engineering student should receive an engineering degree unless the average of his ratings by instructors reaches a high prescribed standard.

12. *The Four-Quarter Plan.*—The writer favors organizing all college and university work on the four-"quarter" plan, extending throughout practically the entire year and repeating essential courses every six months.

13. *Outside Engineering Practice for Engineering Students.*—The writer favors requiring each engineering student to complete at least nine months of actual engineering practice outside the college before receiving an engineering degree. Such work should be under outside employers but with some general inspection by the engineering college. The four-quarter plan of operation would enable this requirement to be met within the four years now required for graduation.

14. *The Engineering Problem Method of Instruction.*—The writer favors trying out the engineering problem method of instruction on a limited scale at first, as an engineering education research.

At the Iowa State College it is proposed to start such work next fall to the extent of 1 credit hour per week in the freshman year in all courses (three actual hours per week by each student with the instructor) and to extend this to the sophomore year if it proves successful.

A specialist will be in general charge, under whom a representative from each engineering department will give part time to the work.

The engineering problem instructors of this group are to be of the grade of associate professors at least, and, when reinforced for this purpose by representatives of the mathematics, chemistry and physics faculties are to constitute a "liaison group" for the coördination of all fundamental and engineering technique instruction, whether by science or by engineer faculties.

Discussion.

F. W. McNair: Mr. President, I regret that we have not more time to discuss this paper. It is a very interesting one, one full of suggestions. There are just two things that I want to say about it.

One is I was very much interested as Dean Marston developed his suggestions to recognize many of them as familiar in discussion to a period of this Society dating back something like ten years I guess—I have not stopped to count it up exactly—and to see how some of the things we were very, very much interested in discussing then are brought up by him as yet important things.

And then I want to say just a word about the S. A. T. C., which, judging by some of the things that have been said, one would think was an odoriferous memory. I want to testify in one case, namely that of the institution with which I am connected, I am very well satisfied that had the war continued a year longer than it did, the work would have been made a success. The institution was fortunate in having assigned as commandant of the post an officer who had had college work, and he appreciated very quickly many of the problems from the teacher's side.

Then too the institution I think was fortunate in having a faculty that were very, very anxious to serve in the war and were very anxious to coöperate with the military people in any possible way.

The result was a minimum of friction, and I think a maximum of good work for the time the organization lasted, and certainly a maximum of promise of what would have occurred in the course of a year.

J. P. J. Williams: Mr. President, there are two points I would like to suggest directly in line with what Dean Marston has brought out.

The first is the matter of experienced teachers and how to get the required compensation for experienced teachers and the disadvantage of using cheap instructors. The solution which occurs to me, if you cannot get the added amount from the executive authorities, is that perhaps the application of the "case" method itself in its working out would make possible the elimination of some of the cheaper instructors and the concentration on high priced men, which means of course using the salary now given instructors to pay the high priced man. Why not work the student, instead of working the teacher or the instructor?

I also believe there should be courses in what you might call "self-management"; that is, resulting from the experience in the war you can easily see the advantage of a course which would teach men how to handle themselves. Give them physical training, physical education, mental ability to analyze; and I would follow it right through to moral development. Self-management after all, if you stop to think of it, is what is needed in practical life. We must get men who are able to handle their bodies, to really get the results that they are desiring to get when they have a practical situation placed before them. And such a course would be easily used in those three directions, as a freshman course, to teach the students how to think, how to study, how to actually make the best use of their time in the college, and in that way be sure that what time is spent by the student in these forty-eight hours or more which you are requiring, will really be productive and effective.

And then I would also like to see credit given for student activities.

The call from the world, the call from practical life is for men of character. Character is developed by association with each other. Why not give credit to the social activities, the student activities in engineering societies, remembering that the Development Committee of the American Society of Civil Engineers and probably of all the engineering societies is advocating student sections in the colleges. Those student sections should be given college credit; and in these student sections can be developed the ability of our young men to present papers, to discuss them from the floor, to really become well fitted for leadership in the future.

Dean Taylor: We might as well get down to brass tacks in this thing. The most important thing in this report is the question of salary. Let us face it and be honest about it. The question is how to get it. Engineers who are graduates of institutions are now superintending bricklayers and carpenters at half the salary the bricklayer is getting. All over the country the movement has taken place in regard to teachers' salaries. Some teachers down in Texas practically agreed to walk out unless something was done. And the City Board met and got together and the citizens got together and agreed on backing a twenty-five per cent. increase for the teachers in the city of Dallas. We were told in Texas that we would probably get a ten per cent. increase, but we realize that food supplies have gone up about one hundred per cent.

Now, there are many vital things in Dean Marston's remarks, but this is absolutely the most vital, because if something is not done, the young men that we may treat as the seed corn of the teaching profession in engineering will go into other lines of cativity.

A. H. Fuller: Mr. Chairman, I would like to call attention to a portion of Mr. Smith's discussion, "The effect of the war on engineering education," in which he points out that one advantage is that it cleared the atmosphere in a way never cleared before, and probably never cleared before for making radical and decided changes should be made.

George W. Case: Mr. President, it seems to me that the severe criticism brought out in the paper, that school faculties are directing against themselves for their reputed failure in the S. A. T. C. work of last fall, emphasizes a matter worthy of discussion.

From what we have heard and experienced in regard to the S. A. T. C. work, we are justified in assuming that some schools were quite successful in handling this work and others were quite the opposite. This is as might have been expected.

University faculties in this country have not had experience in working with our army organizations. The two organizations have had no opportunity to coöperate on a job. Therefore, the first time they try, one need not expect full success to crown the effort. There is really no reason for this severe criticism.

In my mind our experience with the S. A. T. C. work emphasizes the fact that if educational work during normal times is going to be as successful as the student and everyone else has a right to expect, members of school faculties must learn to give each other the fullest coöperation.

O. M. Leland: Mr. Chairman. I think one of the great effects of the war that has shown itself in education has been the number of schools that have been established in connection with war work. Two years devoted to war so far as this country is concerned have done a very great deal educationally, and new methods have been evolved, and the schools have been adapted to all comers without regard to their qualifications in many cases. I think the result is going to be that there will be a great stimulus in engineering schools, as pointed out by Dean Marston, in that a great many men who are now perhaps a little too old to undertake the usual entrance requirements of engineering schools will go after special courses. Their interest has been aroused in engineering, perhaps through their attendance at trade schools or engineering schools in the Army.

One of the things that came to my attention most prominently in the war service was the fact that you can accomplish almost anything with almost any kind of human material in the way of education if you only cultivate their interest in the work that you are giving them.

I had the unique experience of having to organize a technical school up in the Schnee-Eiffel of Germany. This school was for soldiers, and there were about five hundred men there. They all worked hard, and had absolutely no diversions outside of the school, although inside of the school we were able to give them some of the usual entertainments provided by the Y. M. C. A. But at the close of this little school all of the men seemed to have been very much enthused by their work; and I think that it was just because their interest was aroused in all of the courses that they took.

It was not entirely elective work, although the students elected the general lines along which they were to study. But every man, no matter what his qualifications, was required for one thing to take a course in practical English, as we called it. He was supposed to receive instruction—and I think he did receive effective instruction—in practical English in the writing of letters and the correction of errors.

E. J. McCaustland: Mr. President, for a number of years educators have been demanding that more importance be attached to the fundamental training underlying engineering education. It appears to me that at the present time the tendency is too much in the other direction, due to an insistent call from the War Department for the establishment of various units. In one institution at least there has been a flood of communications from various quarters, different branches of the army, to establish special units. Administrative officers in some universities are desirous of attempting to do everything that may be asked. They do not like to be left out of any scheme that may be developed.

I believe that this body of engineering educators should give some attention to the possible danger that may come from this source.

R. H. Danforth: I am very much interested in three or four points that have been brought up.

Starting out with Dean Marston regarding the question of fixing our courses to meet the needs, I would like to call attention to the fact, as the last speaker suggested, that military needs are only a comparatively small fraction. They may be the most pressing ones at the present time. But they are comparatively small, and the probability is that they will absorb a practically small fraction of our graduates.

Regarding the case method, we apparently got the jump on some of the other organizations a little while ago for this very thing: We got together about sixty of our prominent graduates from the Cleveland district and had a pow wow with them. Most of them are employers that are employing our own men, and others were in a position where they could advise us, and we have gotten them to agree to form a sort of an alumni organization which shall advise us to the best of their ability as to what the demands of the country for engineering graduates will be five years after each class graduates, because we feel that five years after the man graduates is about the time when he begins to work on his own initiative; so that that means we are trying to look ahead into a period of ten years and forsee as well as we can the needs of the country, and the needs of the people who are going to hire our men at that time.

Now, that has not gotten into effect yet where I can give you any definite data on it, but I am offering it as a suggestion that we have got to train our men to meet the requirements of the world, the world of employers, and by just so well we meet that need do we make good as engineers and engineering organizations.

Of course there is a great deal to be said about the head of the department who has men, specialists in a line, and who is supposed to know the needs of the world in his line. But the mere fact that he is a specialist frequently vitiates that to a large extent; and that is why I suggest going after the alumni.

CHANGE IN COURSES AT UNIVERSITY OF FLORIDA.

BY J. R. BENTON.

My only excuse for taking your time to describe what is being done at one of the smallest of engineering schools is that our problems at the University of Florida are probably similar to those of a good many other engineering schools at institutions remote from industrial centers.

The appearance of Dr. Mann's report has been the occasion of an effort to realize a number of the changes suggested by him, which we had already regarded as desirable, but which we had not introduced before, either through inertia, or for fear that we would deviate too much from what had been customary in other institutions. The changes we are making take effect next fall.

Dr. Mann's first suggestion is that the number of required credit hours per week should be less than eighteen—preferably sixteen. In discussing this, we found the credit hour so unsatisfactory a unit that we abandoned it, and used clock hours, as was done during the S. A. T. C., and as is done at the Massachusetts Institute of Technology. For each course we noted the clock hours required for class-room work, for expected outside study, and for laboratory, field or drafting room. The hours of outside study for each hour in class were usually two, but were varied for different subjects. Next we tried to discover what quantity of work per week would produce the greatest results. And we did not do this by any arbitrary statement that an engineering student ought to be willing to put in fifty-four hours a week, or any other arbitrary number. Instead, we looked up a little industrial history, and verified the fact, doubtless familiar to you all, that reduction in working hours in factories—down to eight per day—has generally brought the employers a pleasant surprise in increased output—not increased output per hour, but increased total output. We also noted that our own experience had been that we could not, without getting brain-fag, keep up as intense mental effort as we wish our students to make, for as much as eight hours a day *every day*. Then we asked the professor of psychology to give us an unbiassed statement as to what amount of mental work per day, for long periods, would produce the greatest results in a normal college student. He replied seven hours of assigned work requiring close attention, with an hour or two of light reading such as current magazines or general literature.

We accordingly undertook to rearrange our curriculum so as to require, in addition to military drill and required gymnasium, not over forty-two clock-hours per week of hard study, or its equivalent. We recognized that laboratory, field and drafting-room work call for less nerve energy than study or class-room work, properly conducted; of the former eight or nine hours a day is not too much; accordingly in making up our total, we counted each hour of laboratory, field or drafting-room as equivalent to seven-eights or seven-ninths of an hour of purely mental work—the ratio varying according to the nature of the work.

To bring our curriculum down to forty-two clock-hours per week (not continuous military work) we had to leave out all electives, and also the modern language, of which two years had been required. A part of the time which had been given to it will in future be devoted to economics and the human side of engineering. We hope that the students will also gain some humanizing influences through better opportunity to join in general student activities, which has been hardly possible in the past without loss of standing in their studies.

While it is generally agreed that engineering courses in the past have been too crowded, we recognize that we may be now going too far to the other extreme, and we expect to be very watchful of the results of our new curriculum, with a view to adding more subjects if it should turn out to be too easy. The engineering courses have been considered the most difficult ones on our campus, and we wish them to retain that reputation.

Dr. Mann's second suggestion, that the number of subjects studied simultaneously be limited to five, could not be followed throughout, on account of the fact that a number of the general courses such as chemistry, English, and mathematics, are given in common for other colleges of the university, besides the college of engineering. A number of other courses are common to students of civil, electrical, mechanical, and chemical engineering. These conditions interfered greatly with freedom in arranging the sequence of work in the course in any one branch of engineering.

We are introducing orientation lectures for the first semester of the freshman year, one hour a week. We did not find it feasible to introduce any technical engineering subjects (except drawing and shop) into the freshman year, but we are trying to bring as many engineering examples as possible into the freshman mathematics and physics.

We regard participation in real industrial work as very important. Situated as we are in a rural community in a state with comparatively few industrial establishments, anything like the Cincinnati coöperative system is hopelessly out of the question. Our best solution seems to be by vacation employment of engineering students, and we are trying to develop that to the point where we can guarantee opportunity for engineering employment in vacations to every student, and then make a certain amount of such work a requirement for graduation. To make a beginning in this direction, I pointed out to all of our engineering students, about two weeks before our session closed, the desirability of their taking summer employment, and at the same time I sent out a circular letter to about one hundred and fifty possible employers in Florida. I had supposed that the difficulty would be in finding enough openings for the students, but it turned out just the other way. Fewer students responded than I had expected, and more employers; so that in a short time I had to write to employers that the supply was exhausted. One reason for the small response of the students was that a great many were obliged to attend R. O. T. C. camps.

In addition to the changes in arrangement of courses just mentioned, we are of course trying to follow Dr. Mann's numerous valuable suggestions in regard to the conduct of the work within each course, such for instance as the use of a good many problems involving commercial considerations.

MODIFICATIONS IN THE ENGINEERING CURRICULA AT THE KANSAS STATE AGRICULTURAL COLLEGE.

BY A. A. POTTER.

In order to arouse and to maintain the interest of engineering students in their work, the Kansas State Agricultural College will require all freshmen engineering students to pursue certain intensive and concrete courses, closely related to the profession for which they are preparing. Each course will count for two semester units of credit and will consist of six hours per week of combined classroom work, laboratory practice and supervised study. These courses for the freshmen students will be given by the older and more experienced teachers in the several departments. The details concerning these intensive courses follow:

1. All freshmen engineering students will be required to take a two-unit course for one semester in plane surveying and a two-unit course for one semester in shop practice.

2. Freshmen mechanical engineering students will be required to take a two-unit course for one semester in the elements of steam and gas power engineering. This will be a non-mathematical course and will deal with the construction and operation of boilers, steam engines, steam turbines, steam power plant auxiliaries, internal combustion engines, gas producers and power vehicles.

3. Civil engineering students will be required to take surveying during their entire freshman year.

4. Electrical engineering students will be required to take a two-unit course for one semester during their freshman year in electrical machinery and construction. This course will include electric wiring, and the operation and repair of electrical machinery.

The above outline has been tried out during the college year 1918–1919 and those responsible for the curricula feel that these intensive courses, offered during the freshman year, will better prepare the engineering students for the more abstract subjects of the later years, while reducing the mortality among engineering freshmen by maintaining their interest. The course, as given, includes about two hours per week of class room work and four hours per week of laboratory work or supervised study. The teachers feel that a limited amount of supervised study enables the students to work problems independently, while aiding the teachers in making the instruction nearly individual.

In order to make room for the above concrete courses, analytical geometry had to be shifted from the freshman to the first semester of the sophomore year and the course in calculus is given during the second semester of the sophomore year and the first semester of the junior year.

THE NEW COURSE AT TUFTS COLLEGE.

BY G. C. ANTHONY,

Dean of the Engineering School.

The sudden departure from the generally accepted curricula of engineering schools which was made at Tufts College last January requires a word of explanation in that it might appear to have been hastily entered into, and its seeming success one of chance. In reality it was the product of five years of investigation, study and experimenting. This was largely stimulated by the discovery, which I reported several years ago, of the apparently universal lowering of scholastic standards during the sophomore year, and it also appeared that some of the intellectual depreciation was chargable to the curriculum. The freshman program has always been rich in fundamentals, but the vision of the prospective engineer has not been equal to correlating the mathematics, physics and modern language with the ideals which have inspired him to enter the field of technical education; he has not been given the opportunity to orient himself early in his course by direct contact with the applied field of engineering.

In 1913–1914 this topic was made the subject of investigation by several faculty committees and a result of their findings was to recommend: (1) A reduction in the number of subjects pursued at one time; (2) a closer coördination of the several departments, and a consideration of the possibility of a single course in engineering for three years with opportunity for specialization in the fourth year; (3) the introduction of engineering subjects much earlier in the course; (4) the necessity for a closer correlation of theory and practice together with an inversion of the usual order by introducing laboratory practice previous to the consideration of much theory.

About this time the work of the Joint Committee on Engineering Education began, and Dr. Mann became known to all of us as a seeker after truth as applied to engineering education. Our faculty kept in touch with this investigation and tried out many of the suggestions made by Dr. Mann as well as those made by members of our own school. It is very apparent now that the reason for no greater success in our experiments lay in the lack of unity in action on the part of the faculty; in the failure to obtain a closer coöperation; in the reluctance of the several departments to put all of the subject matter into the educational melting pot; and in regarding the problem as one of professional training rather than of broad educational development.

It required the world war, its demand on all our resources and the doing of the seemingly impossible to overcome these obstacles. Vocational training in untried fields with inadequate equipment, indeed with no equipment whatever, necessitated the abandoning of time honored, but antiquated methods, and the adoption of means, not altogether desirable, but which sufficed to accomplish the desired end.

Previous to this we had tried certain intensive courses which were open to students of high grade who had completed one half of the senior year in high school. One such course was designed to meet the demand for a short cut method in the training of an electrician. The pupils began the course with much laboratory work and little instruction in theory. The latter was considered later when the intellectual appetite had been greatly stimulated by the attempt to overcome obstacles of a practical character. The results, which were largely due to the interest and enthusiasm on the part of the students, far exceeded our greatest anticipation, and this experience stimulated us to seriously consider the adoption of the principle which we had previously declared as good, namely, that more practice should precede theory.

Thus, when we experienced the upheaval due to the demobilization of the S. A. T. C. we were ready to sacrifice much to the melting pot, and the psychological moment for the inauguration of the new course seemed to have come.

THE NEW COURSE.

The ideals which we aimed to realize through the new curriculum were: (1) To present a survey or perspective of a chosen field of engineering previous to a detailed study of fundamentals; (2) to coördinate theory and practice by using projects of a distinctively engineering character involving theory; (3) to reduce the number of subjects studied at one time while intensifying the work in these subjects; (4) to rate the student by observations on his character as well as by the quality and quantity of the prescribed task.

Our first step in the simplifying of the curriculum was to reduce the number of departments from four to two by combining the electrical and mechanical departments, and the civil and structural departments. It is the curriculum of these combined departments which I shall describe.

The most radical feature and basic principle in accomplishing these ideals is that of introducing the student at the beginning of his freshman year to a main introductory course in his chosen field of engineering to which he will devote about one third of his time. This is designed to give him a perspective of engineering practice and an acquaintance with the instruments and vocabulary of the profession. It consists of laboratory practice, recitations, and the necessary preparation, all of which will be described later.

The remainder of his time is given to mathematics and the art of expression through the medium of the English and graphic languages.

At the beginning of the sophomore year it is possible for a student to change his department and not lengthen his college course, but if he continues in the same department he will take twelve hours of work in that department during this second college year. He will also be required to take two supplementary courses, one in the alternate department and one in that of chemistry, each requiring eight term hours. The fourth subject in the curriculum is that of mathematics and mechanics which will be taught as one subject.

In the junior year the departmental work is increased to eighteen hours to which are added applied mechanics and physics. This program will permit of one elective.

In the senior year one subject only is required, namely, engineering economics and business law, but if the student avails himself of perfect freedom in election and completes the required number of hours, which is 136 for the four years, he will receive the degree of bachelor of science in engineering. On the other hand, should he specialize in electrical, mechanical or civil engineering, fulfilling special requirements in these departments, his degree will read bachelor of science in mechanical engineering, electrical engineering or civil engineering.

The Main Introductory Course.

The most important feature of the new curriculum is the main introductory course which is conducted on the project plan. This is largely laboratory work accompanied by systematic instruction and recitations. Four distinct projects or fields of practice are assigned in each department.

In civil engineering these projects are designated as jobs and a number assigned to each as would be the case in office work. Two of these comprise, for the present year, the study of garages, one of wood and one of steel. In the first students were required to meet the following requirements: (*a*) Make sketches and measurements of the building; (*b*) make one eighth inch scale drawings of plans, sections and elevations; (*c*) estimate the material; (*d*) study the structure with respect to the following: (1) Computation of loads on members, (2) discussion of materials used and their suitability, (3) laboratory tests on beams, (4) consideration of the strength of beams.

In the case of the steel structure the students were made familiar with various structural shapes and methods of riveting by a visit to the mill. They were then required to prepare detailed drawings of the steel beams, columns and trusses of the garage. Although preceded by no course in mechanics, the graphic analysis of the forces in the simple structure was obtained, and the strength of the several component parts was figured by the use of a hand-book. McCullock's "Practical Structural Design" and the Carnegie "Hand-Book" were used as text-books and a practical course in drafting accompanied the recitations and the making of estimates.

A third project was that of a small highway bridge. Freehand sketches and measurements were made of the structure from which plans, elevations and details were prepared in the drafting room. This was accompanied by a study of the mechanics of stresses and the valuation of the structure.

The fourth project was a preliminary layout and survey for an underground tunnel for a central heating plant. It comprised an introductory course in plane surveying, including the use of transit and level, topography, plotting contours, stadia profiles, note keeping, and map-making from field notes.

These four projects comprise the year's work for the freshman in civil engineering, and necessitates three laboratory periods and three recitation periods per week.

Similarly the mechanical and electrical department, conducted its main introductory course by dividing the work of the year into four parts, two for steam and gas engine projects and two for electrical projects. In the mechanical department the projects were subdivided into a series of jobs. For example, one of these was the measurement of power developed and delivered by the steam engine. Thus the student became familiar with the reduction of motion by the pantograph, the recording of pressures by the indicator, the measurement of areas by the planimeter, and finally the absorption of power by brakes. This made necessary á study of the mechanics of these topics sufficient to give a proper understanding of them. Coördinated with this was the text-book work in the elements of steam engineering, including auxiliary apparatus.

In the second project the student was introduced to the field of gas engines via the automobile. Through the disassembling and assembling of various types and the running of the engines he became familiar with other types of mechanism, and this was done to impress him again with the need for more advanced study in theory which was beyond his reach because of the elementary stage of his mathematics, mechanics, physics and chemistry.

Another approach to this same appreciation was through the study of machine tools by sketching the mechanism; figuring the velocity ratios of change gears and shaper mechanism; and drawing a simple crank diagram. This course is closely coördinated with that of graphics.

In the department of electrical engineering the student was attacking such problems as the distribution of potential in a lighting circuit, a study of the operation of batteries, and the calibration of watt hour meters and volt meters. This work was varied to meet individual needs and to utilize a student's previous preparation or experience. The student was placed on his own responsibility and in general his text-book work followed instead of preceding the experimental work. Thus in dealing with the subject of batteries, the student was first made familiar with the constituent parts of storage cells and then required to make all the connections for charging a six-volt battery by three common methods, namely, charging from 110-volt D.C. current through lamps; by a small motor generator set; and by means of a Tungar Rectifier. He was also required to compare the results and determine the cost of an eight-hour charge by each method.

I can well understand that the methods used in this introductory course may appear superficial and suggestive of a smattering of professionalism in catering to student interest only, but the results prove the error of this supposition. If you have not tried this sort of thing in a well organized and properly coördinated course, you have no conception of the interest, enthusiasm, and keen desire for the more advanced theoretical work which is produced on the eager and receptive mind of a freshman. An increase in observation is one of the most noticeable products of this training, and the students have noted the effect on themselves. Of course it is educational heresy to talk about moments of inertia, stresses in trusses and the strength of structures before a student has acquired a working knowledge of calculus, passed all the requirements in physics including light, sound and electricity, and has a working knowledge of descriptive geometry, shades, shadow and perspective, to say nothing of French or German, but the proof of the pudding is in the eating and the test of the educational system is an educated man, regardless of the thing he has studied or the progression of the subject matter.

The project method does not permit the teaching of fundamental subjects in an unrelated manner, and unless the student is made to see the inter-relation of these subjects and to appreciate the value of a more extended and theoretical study at a later period, the main object of the method will be lost.

It may be of interest to note here that each of these projects has been tried out four times during the past six months with increasing interest and appreciation on the part of the faculty and the student body.

One of the unexpected results of the introductory course was the beneficial effect on the English of the freshman year. The department has attributed this to the fact that the students had something to write about, and showed a very great desire to express it not only in writing but from the platform where they have been called to explain many things to their fellow students and discuss the course itself.

The Curriculum of the Upper Classes.

Concerning the special features of the second, third and fourth years I need only call your attention to a few points which are as yet untried.

Save that extra elective hours will be granted to the better students we are able to reduce the number of subjects taken at one time during the freshman year to four, and five are required during the sophomore and junior years.

Where a number of related subjects are scheduled as one, for example, the machine drawing, mechanism and machine laboratory, of the sophomore year, it will be possible to give greater freedom in expanding and contracting its several divisions to meet changing conditions in the department and the varying needs of classes.

The postponement of physics until the junior year is one of the suggestions of the Joint Committee Report and will insure a much more cordial reception for this subject by reason of the increased appreciation on the part of students.

There is a slight reduction in the amount of required mathematics but more freedom is granted in the senior year for those to whom the higher mathematics may be a profitable study.

Modern language as a required study will be discontinued but special opportunity for its continuance as an elective will be afforded. A new feature of the courses in French and Spanish will be the introduction of reading and lectures relating to reconstruction problems and the international trade relations, especially with Spanish speaking countries. This might be a rather difficult coördination to realize if it were not that the personnel of our faculty is peculiarly adapted to this combination.

The closing of the required engineering courses at the end of the junior year for those who wish greater freedom in election is in recognition of a demand which has increased during several years past. This has come from those whose taste for the humanities has been cultivated through technical training which has been properly correlated with languages and economics. My somewhat long experience has led me to believe that the so-called cultural studies are not necessarily cultural when prescribed at the beginning of a technical course. The desire for these subjects should be a natural growth under the influence of instructors who have a sufficiently broad vision to realize that even technical education does not depend entirely on subject matter but is an assimilation of everything that goes to build character. If a student of engineering has not acquired some love for literature, art, and the humanities through the influence of his course, I cannot but feel that there is something wrong, with something or somebody somewhere.

On the other hand if the student desires to specialize to a high degree during his senior year, I believe it wise to open the gate wide to this field of education, and the new course provides amply for such an opportunity.

To summarize the foregoing our aim in the new curriculum is:

1. To utilize the interest and enthusiasm with which a student enters the technical school by introducing him at once to real live engineering problems, and to so vitalize the task that the disciplinary value of study ceases to appear as such.

2. To make the freshman year of such value that if circumstances force the student to discontinue his course he shall have acquired a vision of greater things, and such training as will afford him some preparation for a place in the engineering world.

3. To determine as early as possible the fitness of the student for a special field of labor and, whenever it may be necessary, to make the transition to another field both simple and profitable.

4. To make the entire course so flexible as to adapt it to the continuous changes which take place in the natural development of the student mind.

Lastly, may we not hope to make the college course effective for that great class of students who have formerly been declared by our faculties as unfit material for the engineering profession and who later happily disappoint us by becoming leaders in engineering practice.

CHANGES IN COURSES AT THE A. AND M. COLLEGE OF TEXAS.

BY F. C. BOLTON.

When I began to think of a few words to say on this subject, I expected to emphasize the desirability of beginning the differentiation between the various engineering courses as early as possible. For some time we have been beginning our specialization in the Sophomore year. We have just been through the curricula, and have decided to continue the plan of specializing in the Sophomore year. I did not realize that I would find so many institutions specializing in the Freshman year.

In the Freshman year, we have one course which I think worthy of mention as it was put in with the idea of giving the student some slight touch of engineering work. This is a course in elementary mechanics, given as an engineering subject and not as a course in physics. We find that this is very valuable in giving the student some understanding of engineering principles and making him feel that he is getting some real engineering work.

In the Sophomore year, we have found it very satisfactory to begin with one course in the student's major department, all the other work being essentially the same for all engineering students. This is followed by more specialization in the Junior year. By beginning to specialize in the Sophomore year, we can keep the student's interest, and we are also enabled to arrange our technical work to better advantage instead of crowding too much of it in the last two years.

One of the things which we got from the war experience has resulted directly from War Aims Courses. We were particularly fortunate in the men who had charge of those courses at our institution, and as a result we have put in a course in what we call citizenship. It has for its object the training of the man to be a better citizen. There are a number of details of the course which have not been worked out yet, but we hope to give the man a better understanding of his relations to his community, to the state and to the nation than our graduates have had heretofore.

Discussion.

J. C. J. Williams: That comes in the Freshman year?

Professor Bolton: No, that is given in the Junior year.

In order to do that, we have had to reduce the amount of time required for economics. We require the fundamentals of economics and make it possible for the student to elect further work in economics. We do require, however, some business law, and this has made it possible for us to reduce the amount of time required for more advanced economics.

Another innovation for us has been the introduction of some required physical training. Before the R. O. T. C. requirements became known, we have decided the Freshman should have at least three hours of physical training.

In connection with the R. O. T. C. and with a view to finding the time, we have made the military work optional or elective with modern languages or with some cultural subjects, one of which is English. We have not done this by reducing the English to a minimum, but we require three hours of English in the Freshman year, three in the Sophomore and one in each of the other two years, and in additions to this the student may elect more English if he does not elect R. O. T. C.

These are, I believe, the essential changes which we have made in the A. and M. College of Texas.

CHANGES IN COURSES AT YALE UNIVERSITY.

BY J. C. TRACY.

Reorganization of the University.

1. Four-year course in Sheff.
2. Organization of Division of Engineering in Graduate School.
3. Appointment of Provost—undivided attention to educational work of the University—chairman of University Council.
4. Common entrance requirements—dropping of Latin requirement.
5. Common Freshman year—with separate faculty and dean faculty selected for teaching ability.
6. Dean of students with assistants to promote morale and coöperate with student council—sole duty.
7. Group system of courses in academic department leading to various kinds of life work just as in Sheff.

Engineering Courses.

1. Readjustment of fundamental courses (mathematics, sciences and English) in scope and content—coördination.
2. Elimination of foreign language as a required study, but two years in each of two such languages still required at entrance.
3. Addition of courses in economics, accounting and business finance for all engineers.
4. Required course in U. S. history and government for all students.
5. Every engineering student required to take summer course in engineering of at least four weeks during each summer vacation.

6. Elimination of two highly specialized engineering courses from undergraduate curriculum and elimination of non-essentials in all engineering courses.
7. Broadening of aim in engineering courses with special reference to problem of construction and operation as well as design.
8. Introduction of brief courses in Freshman and Sophomore years to promote interest of the student in engineering, to acquaint him with work of different branches and to show him how principles and methods studied during first two years will be used afterward. (First two years common for all engineering students—part of third also.)
8. Transference of all courses in mechanics, including mechanics of materials, to a new department of engineering mechanics to which Professor Tilden has been called as head of department.
10. Reduction of hours of required work to a maximum of forty-five, at the same time raising the standard which must be attained by the student.

Discussion.

A. A. Potter: I just want to say one word in reference to Major More's statement as to the meaning of teaching. I believe he is wrong. The word teach means to draw out. The English word take comes from that.

G. R. Chatburn: Educate means to draw out.

G. L. Anthony: May I correct one misapprehension in the teaching I have described here, and that is that the shop work has disappeared. By no means; it is still there; it does not appear, but it is part of the departmental work. Also that although specialization does appear in the senior year there is absolute freedom for change.

E. H. Rockwell: Mr. President, the time is altogether too limited to go into any extensive discussion of this scheme which Dean Anthony has so well explained in relation to the new work at Tufts College.

I should just like to add a word of testimony as to the result. Last December Dean Anthony and myself both explained what we had in mind for the future. At that time we were the only members present which we have here this morning, and he detailed some of the projects.

I think at the present you can tell a good thing about accomplishments. We actually have accomplished what we wished to do in a normal year, because we have done this work in relation to the introductory course in an intensive way from the first of January until the first of July by adding brief periods. The Freshmen have actually met their instructors in the introductory course for fifteen hours a week.

This method seems to me very similar to the case method or the project method, or any of these various methods which have been discussed in which the actual problem is given to the student for study; and it strikes me that a great deal of the discussion has centered around this change in our attitude in relation to the method of teaching.

Now, I do not know that it is any more difficult whether theory or practise should come first. History seems to show that practise or art has come first and then science followed, as has been stated by a previous speaker this morning. Perhaps some testimony in relation to the course can be given in the form of reaction upon the students.

Now, as I have stated, they have actually put a tremendous amount of time at their disposal, and they have given up all their afternoons from one thirty to five thirty every day of the week, and those Freshmen are enthusiastic in support of the class, and the upper classmen seem very much peeved, to use a slang phrase, not to be given an opportunity which they think should be theirs.

Two Freshmen from the civil engineering department went into town and looked for a job that was advertised. It happened to be an engineering job in connection with the construction of a building in Cuba, and they went to the office and showed the work they had done. They talked it over, and told what they were doing in previous years, and were offered one hundred and fifty dollars a month on the condition that they would stay at least one year; and both Freshmen refused the job. And they came to me afterwards and told me that they felt that they could not afford to give up any course which gave them so much opportunity.

This matter of the reversal of our usual practise in teaching is not a matter of snap judgment at our institution. There are at least five or six members of the faculty who have given a great deal of time to what may be called extensive teaching to men who are engaged in engineering practise. These periods of time extend from fifteen years of such work down to a period of two years; and I think there are at least five or six members of the faculty who have done that kind of work. That work has been done very largely by this method. And I believe that the outside teaching done by these members of the faculty has been productive of considerable breadth of view on the part of the faculty in relation to the methods of teaching.

I would add only one word and say that when it appears to me that the dean and the faculty and the students are enthusiastic about this thing, there must be something in it.

Professor Hickerson: I would like to ask the Dean of Tufts College why so little is given in highway construction? So many institutions offer new courses in this subject. It certainly is one of the biggest fields in civil engineering at present. I notice you only give three hours a week as part of the course as railroad and highway engineering. How much time is devoted to construction?

Dean Anthony: Mr. President, I will say in answer, that there will be more opportunity for it in the senior year. That subject will be touched upon in departmental work also. In the senior year work we propose to give a man very great freedom in any line we are teaching in college.

THE UNCONSCIOUS PLAGIARIST.

BY G. I. MITCHELL,

Assistant Professor of Electrical Engineering, University of Pittsburgh.

The honor of the technical profession is always high; the technical man guards his statements with jealous care and is generally careful to acknowledge the source of any idea not his own. But what are we to think of the authors of technical books who permit matter to appear in their pages that has been taken from copyright material already in existence?

Take the case of the college professor who, let us say, is the head of the mechanical engineering department and is teaching machine design. Not being satisfied with the machine design texts already in existence, perhaps because the order in which the work is arranged does not agree with his opinions of the subject or because the various relations developed do not meet with his approval, he gets together a set of notes, has them mimeographed and hands a set to each of his students.

Because these notes have been arranged according to the professors particular notions he finds that they just suit his fancy, he can teach the subject with less friction and with less effort on his part—he does not have to correlate his ideas with those of another. He seen comes to be a firm believer in the fact that he has hit upon an ideal method of teaching his subject and condescends to have his notes published as a textbook that others may have the benefit of his broad intelligence.

Very good. He has been actuated by the best motives. But let us see how these wonderful notes have been collected. Did he sit down at his desk and evolve them from his own mind? The chances are very few that he did. No, he consulted every published text that he could get his hands on and picked out the parts that best suited his own ideas, one part from one author and another part from a second and so on. Page after page of his notes was copied verbatim from other men's books, the professor merely running in a few words here and there to avoid a too abrupt change from one authority to another. Since he was simply compiling these notes for his own use he was not careful to give references to the men who were responsible for the subject matter.

After the lapse of a few years the professor has forgotten just whom he consulted, has forgotten just how he got these notes together, so that when he makes up his mind to publish his text he simply bundles the pages together and sends them off to his publisher. When the book appears it is submitted to the public as a "new and better" text in machine design. It finds its way into schools, the men from whom the author cribbed various parts read the new text and are somewhat surprised to find page after page of their own material. Letters begin to pour into the office of the publisher, causing the publisher much discomfort. But what can the publisher do? He has printed the text in good faith, depending upon the integrity of the author to prevent unpleasantness of this nature, but the publisher is more or less responsible, and to say the least, is in a bad position. The author himself looses caste and is regarded as a thief by his brothers.

The remedy is easy to find. Let every author of a book of this kind search his notes with care and wherever questionable material is found let full credit be given or let him give the old material new treatment so that it will appear in his new book in the author's own words. If the book is worth while it is certainly of the utmost importance that the writer keep his escutcheon clean, with his name placed high in brilliant letters on the roll of his profession.

REPORT OF COMMITTEE NO. 11A—PHYSICS.

Your Committee on Physics has made but little progress during the past year. Previous annual reports show that the committee has been attempting to establish complete coöperation between the two courses in mechanics (one in general physics) studied in the engineering course. As soon as the Committee on Physics was informed of the discontinuance of the Committee on Mechanics to whom a report has been submitted and with whom work was under way, communication was at once established between the new Committee on Mechanics and Hydraulics and the Committee on Physics. A coöperative effort between these two committees is now in progress and immediate attention is being focused upon the content in the physics course in mechanics.

G. W. Stewart,
Chairman.

REPORT OF COMMITTEE NO. 11B—CHEMISTRY.

Your committee begs to report on the progress of its studies regarding courses in chemistry in engineering schools.

In December President Nichols of the American Chemical Society, at the suggestion of Mr. Bishop, appointed Professor Talbot, of the Massachusetts Institute of Technology, Professor Parr, of the University of Illinois, and Professor McKee, of Columbia University, a committee to coöperate with your committee in the study of chemical education. Later Professor Talbot was forced to resign on account of ill health and Professor Bird, of the University of Virginia, was appointed in his place.

Up to January first most of the members of the committee were engaged in war work for the government, and for some time thereafter they were occupied in straightening out their affairs and reëstablishing their courses following the renewal of university work on a peace basis. Nevertheless, correspondence was had on the subject of the work of the committee. In April Messrs. Withrow, Parr, McKee and Bird met in Buffalo and discussed the work of the committee at considerable length. It was agreed that each of us would give thought and study to three phases of chemical and engineering education, communicate the results of such individual study to the other members, and later meet to collaborate these studies and prepare a report for your consideration.

The three phases mapped out are:

"The limitations and content of first-year courses in general chemistry," with a view to laying the most thorough foundation possible for the further study of the science by those who plan to become chemical engineers. It was thought that if the content of the first-year course is carefully limited to so much as may be learned with great thoroughness, the results will be better than at present, when much has gradually been added until the beginner finds himself consuming more than he can digest.

Second. "A consideration of what further study of chemistry, if any, is desirable for those pursuing other lines of engineering."

Third. "Graduate courses in Chemistry." Professor McKee submitted plans for a differentiation of the work of different universities in the advanced study of the several lines of applied chemistry. The idea is that one or more universities shall develop to the highest possible degree research work and its application along such line as is of most important in its state, rather than to attempt to cover too many fields. This plan looks to great schools in each of the several divisions of the field, where a student may learn the last word under the best masters.

The individual studies are now being made, but sufficient time has not elapsed for their restudy by other members of the committee and their collaboration. We therefore respectfully suggest that the committee be continued for another year. We hope that more normal times will permit a more careful consideration of the subject than has been possible during the troubled months of the war and the beginnings of reconstruction.

R. M. Bird,
J. R. Withrow,
J. H. James.

REPORT OF COMMITTEE NO. 12, ENGLISH.

C. W. Park, *Chairman,* University of Cincinnati; Frank Aydelotte, Massachusetts Institute of Technology; J. R. Nelson, University of Michigan; S. A. Harbarger, New York City.

The gradual return of normal academic conditions, following the S. A. T. C. period, is encouraging to the committee, since much work can now be resumed which had to be set aside last year. From communications that have been received since the re-opening of the colleges, it is evident that the temporary suspension of the usual courses has been in some respects beneficial. Instructors show a disposition to revise their subject matter and methods, and they bring to the revision a variety of experience and a fresh point of view, gained in some form of war service. The new start in all lines of instruction makes the time a propitious one for a re-examination and, where desirable, a reconstruction of the curriculum.

Fortunately, just when conditions are most favorable for the introduction of changes in materials and methods, the report of Dr. C. R. Mann on "Engineering Education" is available as a guide in reconstruction. The publication of this work at any time would challenge a testing of every instructor's work by the standards of engineering training which it sets forth. Its appearance at this time is highly significant.

Among the passages in Dr. Mann's report which bear upon the question of English instruction, the following are regarded by the Committee as being especially suggestive.

"With regard to instruction in English, the engineering schools may be divided into two approximately equal groups, the one composed of those schools that maintain the current standard college course; and the other composed of those that are trying to discover a type of work better suited to engineers. In the standard type of course, the student studies a text-book of composition and rhetoric, learns the rules of correct punctuation and paragraphing, together with the four forms of discourse, and then writes themes on assigned subjects selected by the instructor to give practice in either description, narration, exposition, or argumentation. In some schools the strict adherence to this plan is mitigated by allowing a choice from among several assigned subjects. The accompanying study of literature consists of a brief survey of the lives of the great writers and the analysis of selected passages from their writings. This well-known type of course was developed during the latter half of the past century for the purpose of making English an acceptable substitute for the classics in high schools and colleges.

"Doubtless because the professional engineers have been so frank in their demand for better training in English, about half of the engineering schools are experimenting with their methods of teaching this subject. These experiments are so varied in plan and execution that it is not possible to classify them." (Chapter VII, page 42.)

"Therefore congestion of the curriculum is inevitable so long as each department remains sole arbiter of the content of its courses, and there is no coördination among departments with respect to the amount and the nature of the subject-matter in courses. and no scrutiny of the results of each department's work by some agency outside the department." (Chapter IX, page 56.)

"At this school (Massachusetts Institute of Technology) English is a required subject for all students throughout the first two years. The first half of the freshman year is devoted to general composition, with the object of eliminating the more common errors of construction and of leading the student to see that excellence in writing comes not so much from the negative virtue of avoiding errors as from the positive virtue of having something to say.

"The work of the second term of the freshman year begins with a class discussion of such questions as: What is the difference between a trade and a profession? What is the meaning of the professional spirit? What should be the position of the engineer in society in this new era of the manufacture of power—that of hired expert or that of leader and adviser? Is the function of the engineer to direct only the material forces of nature, or also human forces?

"Having discussed the question: What is engineering? the class proceeds in the same manner to wrestle with such problems as: What is the aim of engineering education? What is the relation between power of memory and power of thought? Is there any connection between a liberal point of view and capacity for leadership? What qualities do practical engineers value most highly in technical graduates? What is the relation between pure science and applied? What is the relation of science to literature? The authors read in connection with the discussion gradually change from engineers to scientists like Huxley and Tyndall, and then to literary men like Arnold, Newman, Carlyle, and Ruskin. The student seems to read this material with no less keen interest than was shown for the writings of engineers; so that through his own written and oral discussion of masterly essays each comes to work out for himself some rational connection between engineering, with which he began, and literature, with which he ends. No orthodox point of view is prescribed; his own reason is the final authority. The aim is to raise questions which it may take half a lifetime to answer, but the thoughtful consideration of which will give a saner outlook on life and on his profession." (Chapter X, pages 63–64.)

"Thus there is a widespread agreement among professional engineers that the college curriculum should aim to give a broad and sound training in engineering science, rather than a highly specialized training in some one narrow line; that considerable attention should be paid to humanistic studies like English, economics, sociology, and history, not merely because of their practical value to the engineer, but also because of their broad human values; and that the young graduate should have some conception of business management and of the most intelligent methods of organizing and controlling men.'' (Chapter XIII, page 88.)

''The humanistic studies make up the fourth type of work essential to the training of every engineer. The professional criticisms of the schools indicate that this field offers the greatest opportunity for effective changes in current practice, because lack of good English, of business sense, and of understanding of men are most frequently mentioned by practising engineers as points of weakness in the graduates of the schools. The criticisms point out two types of weakness, namely, lack of technical facility in expression, in business, and in handling men; and lack of appreciation of and interest in literature, economics, and social philosophy. Clearly the humanistic departments are not alone responsible for these weaknesses, for no amount of drill in the technique of language will make a student write and speak clearly if he does not think clearly; and training in clear thinking is as much the function of the teachers of science, mathematics, and engineering as it is the function of the teachers of English. And if the professors in the technical subjects rigidly exclude from their instruction all discussion of human values and costs, is it reasonable to expect the students to appreciate economics and social science? As every one is aware, languages, economics, and social sciences are generally treated as 'extras' in curricula, and are as generally regarded as superfluous 'chores' by the students.

''The difficulty in present school practice evidently lies in the exclusion from the technical work of all consideration of the questions of human values and costs; and, conversely, the isolation of the humanistic studies from all technical interest. The theory has been that engineering at best is tied to materials; but that it can be made less materialistic by ignoring the question of dollars and cents in the technical work, and by teaching science, mathematics, economics, and literature for their own sakes entirely isolated from inherent technical relationships. This conception, however, is gradually giving way, for the experiments described in the last four chapters indicate that technical work is more impelling, and is, therefore, more fully mastered, when it includes the consideration of values and costs; while humanistic work becomes significant, and therefore educative, when it starts from and builds upon the professional interest. And after all, the ultimate control of all engineering projects, as of all activities, is vested in some man's decision that the game is really worth while; and this control is likely to be more salutary, the more completely the man who decides comprehends the full import of the values and costs involved." (Chapter XIII, pages 92–93.)

"Because the appraisement of values and costs is the controlling factor in engineering, the final important change from current school practice that is suggested deals with the humanistic studies. The usual method of treating these subjects in short independent courses in the technique of composition, literature, history, economics, and so on, seems less likely than the method proposed (page 92) to develop the desired insight into these profound problems of value and cost. The experiments at Wisconsin and the Massachusetts Institute have progressed far enough to show how successful this type of work is with freshmen in developing powers of both forceful expression and appreciation of good literature. Therefore it seems reasonable to expect that the extension of this work into a consecutive course extending through the entire curriculum and consisting of live discussions and extensive study of the best that has been thought and said concerning the immediate and the ultimate values in life, offers the most promising solution of the problem of culture for engineers." (Chapter XIII, page 99.)

"The statement that individuality counts for as much as learning for the engineer, just as it does for the lawyer or the physician, seems like a veritable platitude. Yet because the engineering schools have always made it their chief aim to impart the technical information needed in industrial production, and because both scientific knowledge and industrial practice have grown so rapidly, the attention of technical schools has been focused chiefly on keeping up to date in science and practice. The university emphasis on research in natural science has also tended to magnify the importance of technique and to minimize the importance of personality, until curricula have become so congested with specialized courses that students generally regard literature and sociology as unnecessary chores, to be endured rather than enjoyed. Therefore it seemed necessary to consider the question whether this emphasis on technique is producing a new and higher type of engineer, or whether the engineering profession still stakes its faith on the fundamental thesis that personal character is, after all, the real foundation for achievement.'' (Chapter XVI, page 106.)

''The organization of curricula proposed in Chapters XIII and XIV is suggested as one practical method of harmonizing the conflicting demands of technical skill and liberal education. It coördinates the results of numerous individual experiments in a consistent program. It recognizes all the essential elements and factors of engineering as well as the educational requirements of motivation and interrelation. It is not a utopian dream, but a summation of the best that has been thought, said, and done in education during the past two centuries. Finally, it embodies the modern conception of the professional engineer, not as a conglomerate of classical scholarship and mechanical skill, but as the creator of machines and the interpreter of their human significance, qualified to increase the material rewards of human labor and to organize industry for the more intelligent development of men.'' (Chapter XVI, page 113.)

In the brief synopsis which follows, the present scope of the committee's activity is indicated. Broadly, its aims are twofold: first, to stimulate discussion of current problems in English instruction for engineering students; and second, to act as a clearing-house for practical suggestions which may be useful to teachers of English in engineering colleges. The first of these objects contemplates a discussion which would interest not only teachers of English but also instructors, administrators, and others who deal with English chiefly as a part of the general scheme of engineering education. The second object has to do with discussions of immediate practical or classroom value, including such exercises, outlines, and other "tricks of the trade" as may be used by instructors and students. Instead of requesting answers to a questionnaire, the committee invites instructors and others interested to send contributions of both kinds to the chairman. The general discussions may be based on the quotations from Dr. Mann's report, the topics suggested in the committee's 1918 and 1919 reports, or on any other subject of interest. The more brief and concrete the contributions, the more useful they will be. Sections of this year's report will deal with such subjects as "The Humanities in the Engineering Curriculum," "The Development and Expression of Individuality," "The Growing Emphasis on Oral English" and "Specialized Training in English for Engineers."

As an example of the kind of material which may be included under "practical suggestions," the following typical outline for a laboratory report is offered. This outline, it may be noted, was worked out by laboratory instructors in physics, electrical engineering and mechanical engineering on the one hand, and by a department of English on the other. The committee feels that on the more formal side of technical writing many such plans exist, which even if not adopted entire, would at least be interesting for comparison. In those even more important phases of instruction which cannot be classified, a concrete description of an instructor's method of approach may be widely useful if shared with his fellow instructors.

TYPICAL OUTLINE FOR A LABORATORY REPORT.

Although laboratory reports differ widely in subject matter, the problem of organization is very similar in all of them. The outline given below represents a logical development of the subject as well as a convenient distribution of the material in the report of a test. With a few changes here and there to fit special conditions, this form will be found serviceable in the writing of nearly every kind of laboratory report.

1. *Object.*—This division should consist of a clear, full, and concise statement of the object, preferably in the form of a simple declarative sentence. Since the report is not written until after the test has been performed, the statement should be put in the past tense; *e. g.*,

"The object of this test was to determine the steam consumption of a Brownell 10 × 12 engine."

2. *Theory.*—This division should contain a general statement of the data to be obtained in such a test, together with the fundamental principles on which the test depends. For example, the second paragraph of the report indicated above might begin as follows:

"In testing for steam consumption, the chief data to be obtained are (*a*) the horsepower of the engine, and (*b*) the weight of the steam passing through the cylinder in a given time."

Where formulas are to be applied in the test, they should be given in this part of the report.

Since the discussion deals with general theory, this section of the report should be expressed in the present tense.

3. *Apparatus.*—The apparatus used should be described, with emphasis on new apparatus and on special devices used in the particular test in question. At the beginning of the section, the various pieces of apparatus should be enumerated. New and special pieces may then be described in detail.

In so far as this part of the report deals with particular apparatus, it should be put in the past tense; *e. g.*,

"The apparatus used in this test consisted of the following," etc.

4. *Procedure.*—This section contains an account of what was done in carrying out the successive parts of the test. Care should be taken to omit preliminary and non-essential operations, and to follow the actual order in which the work was done.

The narrative should be impersonal, and should be given in the past tense and the passive voice; *e. g.*,

"Readings *were taken* at intervals of five minutes," etc.

5. *Results.*—(*a*) Summary of results: Conclusions drawn from the data should be stated briefly and clearly. In some cases it may be desirable to compare them with results obtained in other tests. (*b*) Curves. (*c*) Sample calculations: These may be brief, but they should be typical of the mathematical processes involved. (*d*) Data: The data should be presented on special paper designed for the purpose, and should be arranged in tabular form and in parallel columns.

6. *Sketches.*

7. *Original Data.*—Rough notes taken during the test should be submitted from time to time as evidence of the accuracy with which observations were made. If a log book is kept, it will answer the purpose.

Respectfully submitted,

C. W. PARK, *Chairman.*

REPORT OF COMMITTEE NO. 13, MECHANICS AND HYDRAULICS.

Topic: Main Objectives in Teaching These Subjects.

O. H. Basquin, *Chairman,* Northwestern University; J. E. Boyd, The Ohio State University; C. H. Burnside, Columbia University; H. F. Moore, University of Illinois; C. I. Corp, University of Wisconsin.

1. The courses to which this report particularly relates are those of mechanics, strength of materials, and hydraulics; portions of the report may be considered to be of more general application. Preceding mechanics, the student has had an introduction to this subject as a part of general physics; he has had a course in calculus, or takes that study along with mechanics.

2. In each of the three courses considered, one of the main objectives is to give the student a working knowledge of fundamental facts and principles. An engineer needs a working knowledge of essentials rather than a superficial knowledge of a wide range of information. One who is not confident of the essential accuracy of his knowledge does not readily gain the confidence of others, and rarely maintains his own self-respect.

3. The course in mechanics makes extended use of facts and principles which the student should have acquired in physics, calculus, geometry, algebra, and arithmetic. A first duty of the instructor in mechanics is to put the essential parts of these prerequisite subjects into working order; and this instructor should not look upon his task as that of doing another man's work. One can rarely secure thorough knowledge of any fact on first meeting it; the early courses cannot give the wealth of illustration and the new points of view that are available in later courses; and repetition at intervals is a particularly efficient method of learning.

4. Similar suggestions might be made with respect to strength of materials and to hydraulics; in fact, with respect

to almost any course of an engineering program. The objective is to put the essential facts and principles into such form that they can be used by the student with readiness, accuracy, and certainty.

5. The student must become proficient in the solution of problems. Under proper circumstances, it is believed that some of this problem work should be done under supervision, for the purpose of giving the student a start in logical thinking and in orderly, accurate, and economical methods. This suggestion is based upon the principle that it is easier to start a right habit at the beginning than to correct a wrong one. The chief danger in adopting this suggestion is that the instructor may not give the proper kind of supervision: he must not be dictatorial but must develop initiative; his work is to make the student do his own thinking in a proper manner—not to think for the student; when the student has acquired this ability he needs no further supervision.

6. Mechanics is an experimental science; experimental work should accompany each course under consideration. A blind person cannot understand the theory of painting because he cannot experience the sensations of color. In a similar way, a student cannot comprehend mechanics unless he can experiment, because it is only through experiment that he obtains the fundamental concepts upon which the subject is based. The student needs experiments to illustrate in a concrete way some of the important derived facts that are developed in theory, to show their degree of accuracy, and to point out their limitations. In this connection it is to be noted that such experiments, to be most useful, should be so correlated with the class instruction that these concepts and illustrations will be given to the student by the laboratory work at appropriate stages in the development of theory in the class room.

7. The successful engineer is an accurate observer and he draws conclusions from data directly obtained from observed facts. Laboratory work is particularly useful in developing habits of observation on the part of the student. A text-book

problem gives a more or less definite key to its solution through its selection of data: this is not the case with problems that arise in the laboratory; here the student has a chance to apply his knowledge to facts that he obtains through his own selection and observation. The instructor who deprives the student of this experience by giving too minute instructions, denies him an excellent opportunity to develop that resourcefulness and straight-forward thinking, which an engineer must have when facing practical problems.

8. Since an act of observation is not complete until the student has recorded and explained what he has observed, the report is an essential part of laboratory work. It serves to fix the observed facts in the student's mind in an orderly sequence and in an emphatic manner, while it enforces thought upon unselected data. While the report should be in good form, the student should be encouraged to limit its contents to essential matter.

9. Many of the principles of engineering are based upon assumptions, while approximations are often made in analyses. Since the student should be taught to think logically, it is of prime importance that the instructor make a sharp distinction between fact and assumption, between strict analysis and approximation. In reaching conclusions, analyses should be used whose refinement is appropriate to the data obtainable, and the limitations of the conclusions should be recognized. These suggestions relate to the development of intellectual integrity; it is not suggested that these matters be given such undue prominence as to confuse the student, but it is highly important that the instructor appreciate them and make them clear to the student on appropriate occasions.

10. The engineer needs a fluent command of good and forceful English. This is largely a matter of habit, and its development can be brought about most effectively by the coöperation of all instructors to this end. Every student should acquire habits of punctuality in the prompt completion of every duty, of numerical accuracy of acceptable grade, of the presentation of work in good form, and of economical methods of

study. Such habits improve the efficiency of instruction and form the beginning of character development. All instructors should coöperate in their formation.

11. Every instructor should regard it as his duty to make his course interesting—not easy or amusing. A course is interesting to a student if he feels that the value that he is able to get from it is large in comparison with the effort that it costs. Interest makes the student put forth his best efforts with pleasure, it makes him observant of cases that arise in his daily life where his knowledge gives new insight, and it tends to make him continue to be a student of the subject after he has left the instructor's guidance. With this in view, the instructor should specialize in making explanations in simple language, using concrete illustrations that will be appreciated by every student. Interest may be stimulated by letting the student know in advance how he will use a principle about to be studied, by allowing the student to do a part of the thinking in the development of a principle, and by so arranging the assignments that the student will feel that he has made some definite worth-while acquisition from each assignment.

12. The instructor should seek to develop in the student such mental attitudes as will assist instruction and be of permanent value to the student. The spirit of coöperation should characterize intercourse between instructor and student. The group system in laboratory work and in field work may be used to develop both coöperation and leadership. Uniformly thorough work coupled with encouragement of the student's initiative will give him confidence in his knowledge and in his ability to apply it. Insistence upon the full performance of every assignment, accompanied with extreme care on the part of the instructor to make appropriate assignments, will tend to develop in the student the feeling that he can and must accomplish every duty set before him. The instructor should understand the relations which an engineer should sustain to the community, to the state, and to civilization, and, when the occasion warrants, he should make his students feel the necessity of assuming these obligations.

13. It is believed that much good may result if the instructor gives due consideration to the following quotation from Thorndike's "Principles of Teaching": "The efficiency of any profession depends in large measure upon the degree to which it becomes scientific. The profession of teaching will improve (1) in proportion as its members direct their daily work by the scientific spirit and methods, that is by honest, open-minded consideration of facts, by freedom from superstitions, fancies or unverified guesses, and (2) in proportion as the leaders in education direct their choices of methods by the results of scientific investigations rather than by general opinion."

SUMMARY.

I. *Objectives of Knowledge.*

1. *Mechanics.*—Thorough training in fundamental facts and principles, enabling the student to recognize the mechanical principles and the mathematical treatment appropriate for simple problems for which he takes his own data.
2. *Strength of Materials.*—Working knowledge of the common theory of elastic action, and its application to the simple members of structures and of machines, paying attention to assumptions in theory and to limitations when conclusions are applied to actual materials.
3. *Hydraulics.*—Thorough understanding of the principles of hydrostatics and of fluid motion, with simple applications so arranged as to bring out the relations between theory and experiment.

Each course should give a thorough drill in all ground covered, using oral recitations, blackboard demonstrations, informal written quizzes, problems, and laboratory work.

II. *Objectives of Habit.*

Certain general habits on the part of a student should be encouraged by all his instructors; among these may be mentioned (1) intellectual integrity, (2) good English, (3) economical methods of study, (4) punctuality, (5) completion of assignments, (6) numerical accuracy, and (7) presentation of work in good form.

III. *Objectives of Attitude.*

For the purpose of making the student's work more efficient and to make him a better man, every instructor should seek to develop in him certain mental attitudes, such as (1) interest in his work, (2) coöperation with his associates, (3) leadership, (4) self-confidence, and (5) duty.

It is believed that the instructor should be a student of the teaching process.

DISCUSSION.

A. H. Fuller: In concentrating this year's report upon "Main Objectives in Teaching" the committee has given an excellent presentation to which it is easier to agree than to take issue. The impartiality or the neglect to be specific, as the case may be, in the nature of treatment leaves an opportunity for putting the committee on the defensive. The presentation which has been made would apply equally well in working from the abstract to the concrete as to the reverse, or, in other words, to the ordinary textbook methods as to the case system or project method. Which does the committee recommend?

If I may relate a little personal experience, I would say that as a war necessity I picked up a section in mechanics (including mechanics of materials) this last year for the first time in more than ten years. Previous to that time, I taught the subject for about ten years, keeping rather close to textbook and recitation methods, excepting that toward the end of the time one three-hour computation period a week was injected.

Wishing to make last year's experience an opportunity for experiment as well as the discharge of a duty, I decided to change the mode of attack as much as the available time would permit and to incorporate some of the features of the project and problem method as developed by Professor More and his staff at the University of Washington* and followed so effectively at the Engineer School at Camp Humphreys during this past year.†

It was apparent that the new method required more time in preparation and a better general understanding of the subject than when a textbook is closely followed, but the results seemed far superior. While admitting that it is not safe to draw conclusions from a single experiment, it seems probable, from this and from observations made elsewhere (primarily during the development of the course at the University of Washington) that the project or case method will give decidedly better results in the hands of an experienced teacher who believes in the system than other methods regardless of the ability and the view point of the instructor. It seems apparent, too, that this method would not be effective in the hands of a poor or inexperienced instructor, but that it furnishes the means of detecting the ineffective teacher and, with proper administration, should be conducive to better teaching.

I would like also to tie this discussion in with that of Committee No. 15 with the assigned subject, "Methods and Details of Teaching Structural Design." In that report mechanics and mechanics of materials were mentioned as a part of the necessary work in structural design. Therefore this whole discussion is pertinent to the other and could well be considered in connection with it. It is interesting to note that in both discussions attention is given to the principle of teaching, including the training of instructors, and to the necessity for making a distinction between fact and assumption at one time and between strict analysis and legitimate approximations at others.

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* "Mechanics of Engineering at the University of Washington," by W. E. Duckering," ENGINEERING EDUCATION, Vol. VII, No. 9 (1917).

† "Comments on the Course in Engineering Mechanics as taught at the Engineer School, U. S. Army," by 1st Lieut. W. E. Duckering. Published by the Engineer School, March 30, 1919.

ADDENDA, COMMITTEE 14—ECONOMICS.

By a vote of three to two, the committee asks to be discharged on the ground of having essentially completed its work and the impracticability of making further studies. Two members of the committee, while having no particular desire to serve further on the committee, believe that there yet remains some work that might be done profitably by a committee on economics.

In the first place, a wide diversity of opinion exists among educators and practicing engineers concerning the proper content of a course in economics to be taught to engineering students. This fact is revealed by a study of the character of courses now offered in various institutions, where one finds practically the entire range of subjects that may be classed as economics, offered in engineering curricula, and also by the variety of conception on the part of practicing engineers indicated by the quotations included in the committee report. A further investigation and discussion of the objectives in teaching economics should bring about a greater uniformity of opinion than now obtains.

If engineering is applied science, it ought to be not only applied physical science, mathematics, physics, chemistry, biology, etc., but it should be applied social science as well. The engineer should be at liberty to apply any specific conclusions, principles or data of the social sciences as well as those of the physical sciences in the solution of his problems of construction and production. Indeed, he ought even to be at liberty to extend such knowledge of social sciences wherein they may apply to his profession by making observations of his own in that realm as he has done in mechanics, heat, electricity, etc. To this end, a committee of the society should be able to formulate a syllabus of economics, comparable to the excellent one already prepared on mathematics by a committee on that subject, which would be of value in coördinating and giving point to the teaching of economics to engineering students.

In the second place, a diversity of opinion exists as to what is sound doctrine in regard to fundamental principles of industrial economics, or, in other words, those principles that should guide the engineer in his professional activities. Mr. H. L. Gantt avers, in the quotation appearing in the committee's report, that the entire fabric of economic theory should be built up around production as the chief factor, a view that is, as he himself points out, quite different to that of the modern school of economists, who hold, in the main, that under present conditions, distribution of the world's wealth is of more importance than production. Adam Smith wrote the "Wealth of Nations" some one hundred and fifty years ago, in which he held that production of more wealth in the world was of primary importance, and John Stuart Mill, more than a half century later, in writing the second classic of economics, modified this doctrine but slightly. The principle of *laissez faire*, or non-interference, is the most powerful stimulus to production that has ever manifested itself in society, and Adam Smith as well as most moderns who believe that production transcends in importance all other factors in economic activity, generally advocate this doctrine as a basis for economic organization.

This is the doctrine that allows industrial organizers to drive whatever bargains they can for materials and labor and then profit or lose accordingly, denying any interests or rights which the public or society may have in such transactions. This doctrine leads to centralization or integration of industrial organization and is the principle under which much of the "big business" of this country was developed in the latter part of the last century. The possibility of enormous gains under such conditions of non-interference serves as a very powerful stimulus to production and this doctrine is very logically advocated by those who think that production is the controlling factor in economic life.

On the other hand, should higher wages to labor instead of larger profits to capital be the aim of the engineer, as intimated by Mr. Gustav Lindenthal in the quotation report? In this case, the engineer would become the co-partner of labor instead of the agent of capital. Is it possible for him to serve both impartially? Would such a policy tend to decentralization or disintegration of industry?

Which of these views is more nearly correct is doubtless a moot question. However, there is no question about the fact that the former view is held by many engineers engaged in production and the latter by many careful students of economics, and it is certainly desirable to have a study of the situation in order to bring to technical education the best thought of the time with regard to the matter.

Moreover, the industrial and economic status of the entire world is now and will be for some time in a flux. The industries face a new alignment in the way of markets. Oceanic transportation is assuming an entirely new aspect, especially for American industries; railway transportation will be repaired and readjusted to serve the needs of the entire country in a more effective and comprehensive manner; and highway transportation is just beginning to have its significance revealed in the scheme of industrial organization. Economic history shows plainly the effect of such factors in the past and these new conditions cannot but have a profound influence upon our national life and economic activity in the future, and a committee might well undertake to attempt to bring before the Society from time to time its observations in this connection.

For these reasons, it has seemed to a minority of the committee that if the society sees fit to discharge the present committee in accordance with its expressed desire, it might profitably reappoint a committee on economics with a changed personnel. Should the society, moreover, see fit to appoint a reconstituted committee, it might be well to place thereon some teachers of economics together with engineers from the different branches of the profession.

C. C. Williams,
Chairman.

Discussion.

A. B. McDaniel: In lieu of presenting a minority report, and as it will be impossible for the writer to be present at the meeting during the presentation of the report of the committee, the following brief statement is presented for your consideration, as a part of the discussion of the report.

My experience during the past thirteen years as an engineering instructor and for about twenty years as a practicing and consulting engineer, has led me to believe that the training given in our technical and engineering schools is somewhat unbalanced, with the emphasis placed on the technical side. In the past, a large proportion of the graduates of technical schools have followed up purely technical work, and relatively few get into executive positions, even along the lines of their professional training and capacity. This condition is due largely, I believe, to the one-sided highly specialized training given in our technical schools, which does not develop those qualities of initiative, resourcefulness, self-reliance and force necessary for success in administrative and executive positions of high responsibility, but does turn out technicians of restricted ability and limited vision. The writer has talked with a number of managers and executives, graduates of engineering schools, and invariably their early experience was along narrow professional lines until some unforeseen condition jolted them out of their "rut," and started them on the road to positions of high executive responsibility.

It is my belief that emphasis should be laid, especially through general lectures to the students in the freshman and sophomore classes of our technical schools, upon the higher fields of usefulness which are open to men of technical training. Our students should be urged to prepare themselves for these higher and wider fields of usefulness. To this end, I believe that every engineering course should contain a one-semester, three-hour course, covering the general field of business economics, administration and management. Such a course should discuss the fundamental principles of business economics, finance, trade, production, labor and transportation. The students should be given considerable outside reading, and be required to solve problems and prepare reports on important phases of the subjects included. It is my opinion that such a course should be administered through the school of commerce, but subject to the approval and general supervision of the engineering school.

The writer has found upon investigation, that a number of the leading engineering schools of the country give a three-hour course in business economics and management, as has been outlined above, and that this course has proved to be a successful and valuable part of the curricula. Twelve hours has been devoted to work of this nature for a great many years, in the engineering course at Union University, with considerable success. However, the writer does not approve of devoting so much time to even a subject of this general importance.

Many teachers of economics have complained of the lack of interest and attention on the part of students in their courses. The writer believes that this condition implies the lack of enthusiasm on the part of the teachers and the improper presentation of the work. A subject like economics presented in a dry, abstract way, with merely routine assignments from text-books, is bound to result in dull and uninteresting presentations. A live teacher, with a background of practical experience in the business world, can easily arouse the interest and enthusiasm of his students by vitalizing the study of the principles of economics with illustrations of their practical application, and especially through the working out of practical problems and investigations of business and institutions. Such a training would give our engineering graduates a thorough working knowledge of the fundamental principles of business economics, which would be of material assistance to them in laying foundations for broad and successful careers.

During the last six months since the signing of the Armistice, the writer has talked with a large number of men who are leaving the government service and returning to the practice of their professions in civil life. The majority of these men have been engineers and architects who have been working for others in more or less subordinate positions before entering the government service. Nearly every man has stated that it was his intention to either go into practice for himself, as an architect, engineer or contractor, or to enter the business side of his profession. Many of these men informed the writer that they had been preparing for this change by outside study of business courses such as are offered by La Salle University, the Alexander Hamilton Institute, and similar institutions. These men uniformly expressed their lack of business knowledge and training for which as they believe, some foundation should have been laid during their college course.

The recent Conference on Commercial Engineering held under the jurisdiction of the Bureau of Education in Washington, brought out very closely the need of training for engineers in various branches of economics and commerce, and sounded a note in education, which the members of this society and the institutions they represent, should not disregard.

In conclusion, I would suggest that those members of this society who have to do with the preparation of the schedules and curricula for engineering courses, should consider the advisability of establishing the following yearly course in economics, this course to be given in the junior and senior years of all engineering courses: First semester, a three-hour course in the general principles of economics; second semester, a three-hour course in the economics of business, covering administration, management, production, finance, trade, labor and transportation.

REPORT OF COMMITTEE NO. 15—CIVIL ENGINEERING.

Assigned Subject, Methods and Details of Teaching Structural Design.

During the two years since the present committee was appointed it has been impossible to get more than two of the men together at one time and, therefore, the work has been done almost entirely by correspondence. After the first few exchanges of letters, it was decided to make the following assumpptions as a basis for discussion.

"1. Structural design includes the treatment of all static structures whose designs are based on scientific principles and mathematical calculations, therefore including structures of reinforced concrete as well as of steel and timber.

"2. The structural design courses are to be considered as a part of the curriculum in civil engineering and must be studied as an integral portion of it and not as independent courses: therefore—

"3. The work of the committee must include a discussion of the general features of the entire curriculum and go into detail for the courses in structural design.

"4. The general curriculum should be fundamental in character and broad in scope."

The tangible work of the committee thus far has consisted of three papers published in the June, 1918, Bulletin and reprinted in the 1918 Proceedings, followed by eight discussions which appeared in the Bulletin for April and May, 1919.

The committee wishes to express a hearty appreciation to the eminent engineers and teachers who have contributed to this discussion. These contributions should prove to be valuable additions to the literature on engineering education, aside from their direct bearing on the question at hand.

As a basis for putting before the convention the conclusions and recommendations which the committee feels may follow these discussions, a brief review is made.

Mr. Fowler suggests that the purpose of the first year of a college course should be to determine the aptitude of the student and that the drones should be removed as soon as practicable. He thinks that self-reliance begins to come during the course in proportion to a thorough understanding of fundamental theory and the ability to apply it; and that this cannot come to a satisfactory degree until the student is able to think in moments, shears and other basic terms.

He advocates work as draftsman, timekeeper or even as laborer.

Dr. Waddell maintains that the rank and file of technical men, the minor draftsmen, the surveyors, the inspectors, etc., do not receive the right kind of training; that they need short, limited, thorough practical courses without frills.

As a ground work for the professional engineer, he still advocates the "higher engineering course" he proposed a score of years ago. He now recognizes a post graduate course will be necessary and would make the undergraduate four years work general and fundamental. He distinctly states that this course should differ materially from the standard engineering course of today.

He does the committee the honor to discuss separately each of the four subdivisions it had made. Among his constructive criticisms for a revision of courses, he calls attention to the discouragement felt by so many freshmen and sophomores in being compelled to concentrate their efforts upon subjects which seem to them at the time to be foreign to engineering without getting even a real glimpse of what they thought they were going to do. He advocates, therefore, for the underclassmen "short preliminary courses in all subjects dealing with structures, so as to teach them the names of all principal parts thereof (including the most important details), the characteristics of the materials that enter into the construction, the methods of manufacture and the different ways of erection to meet the various conditions."

He emphasizes the necessity for giving attention to the training of instructors by adding to Professor Smith's five essential qualifications of a good teacher, four others relating to practical experience, interest in the profession, economic phases of design and ethics and equity.

Mr. Gillette, in his discussion, refers particularly to Mr. Burt's paper on "Objects of a Structural Course," and he heartily commends it. With Dr. Waddell he believes there is need for radical changes in present day courses. His criticism centers upon the tendency, as he finds it, to discourage (he uses a stronger word, atrophy) the instincts of exploration in the student.

He expresses a fear that the present tendencies to emphasize principles may be carried too far and would reverse the usual order by teaching details first as a background for principles. He suggests the formation of habits (of study and work) as the prime object of college work.

He follows a number of definitions of structures and structural engineering with a discussion that is interesting and to the point.

Mr. Lindenthal finds an under supply of skilled structural men and an over supply of poor ones. He believes that most students are kept at school too long; that only those should be allowed to remain after their twentieth year who are worth educating for the higher branches of engineering. Those who are dropped should go directly into the trades and the more apt of them eventually given special training in night schools to provide recruits for foremen, superintendents and practical managers.

Professor Basquin feels that the committee has not given the necessary attention to the matter of training of instructors. He offers a few suggestions for approaching this neglected field and emphasizes the need of systematic work.

The committee early recognized this as an important phase of its work and regrets that it was not given more attention in the discussions.

Mr. Hollister finds it necessary, as the committee did, to express his views on education in general, as a background for specific discussion of the matter at hand. He says the object of any educational process is to awaken the spirit; that the process is dynamic and deals more with the relationship of accumulated facts than with the retention of facts for their intrinsic value. He closes as he opens with emphasis upon methods of teaching and the insistence that real live vitality is an essential ingredient.

He makes the usual plea for a broad course and suggests that much of it should be considered as a background for the accumulation of details during subsequent study and practice.

He states the generally accepted fact that structural engineering is founded upon the mechanics of engineering and upon the theory of elasticity, but recognizes the need for much greater emphasis upon the latter than is usually given to it.

He believes in a more rigorous undergraduate course than now prevails as well as a broader one, and the four years' training should be supplemented by graduate work, which delves deeply into the theory of structures.

Mr. Godfrey contends that the emphasis, in college work, is wrongly placed; that theory receives too much attention and "ordinary horse sense" is inexcusably neglected. He cites a number of failures of engineering structures to sustain the position; and, to make his criticism constructive as well as destructive, gives many an illustration when a structure could have been saved, and theory left unscathed by a searching review from a purely practical standpoint.

We cannot but agree with him that an instructor's success will be enhanced as he succeds in instilling the common sense view point into his students and we will hope that this can be done in connection with rather than at the expense of a rigorous theoretic analysis.

Mr. Schmitt makes effective use of the opportunities, the powers of observation and the facility of expression of the technical editor. He not only agrees with previous writers that the present day courses need revision but points out that just now an opportunity exists for replanning courses and revising methods that has never come before and that may never come again.

He agrees also with Dr. Waddell and Mr. Indenthal that a large proportion of the college men do not get value received from the present engineering courses. He joins the former in a request for a short practical course as a quicker means to prepare the routine man and a higher engineering course for the one with the ability and the inclination to dig deep, recognizing also that this may have to be more than four years in length. He makes the suggestion that, for local reasons, the two may have to be adjusted so as to coördinate to a certain extent.

Mr. Schmitt notes that practice and the schools are not in complete harmony and assumes that the trouble lies chiefly with the schools. At least he says it is the school's duty, to the state as well as to the student, to equip the student for the demand, not to equip him for a non-existent demand or to misequip him for the existing demand.

The committee admits the premise without accepting the conclusion in its entirety. No doubt the schools could devote more study to the demand to advantage; but wouldn't the harmony which Mr. Schmitt fails to find be more apt to follow from coöperation between the colleges and the employers of college men? Are we sure that the present "demand" is the best for all concerned?

In direct reference to the structural courses, Mr. Schmitt calls for unity of treatment. Teach structures, he says: emphasize the structural principle rather than teach this or that class of structures. He thinks that the teaching of design as a specific subject is a mistaken policy. He would use examples of design when necessary to illustrate principles.

It is significant to note that nearly all of the men who have participated in the discussion seem convinced that quite decided changes in present day curricula could be made to advantage; that nearly all ask for greater emphasis on fundamental principles and a general broadening of viewpoint for the professional engineer; that a few of them want to provide graduate work for the exceptional man and to provide a shorter course, perhaps two years, for the routine man of not more than average ability; that about half of them feel that methods of teaching need attention and that this involves definite training of instructors.

The foregoing conclusions will serve as a basis for recommendations by the committee and should be of value to any faculty in making a revision of curricula. The committee would have welcomed a larger number of definite suggestions for effecting the various changes which have been proposed. Those who have taken part in the discussion no doubt realize, as the members of the committee do, that the spirit with which the work is carried out is of more importance than the details of arrangement. A reading of the discussions will disclose many statements to that effect.

The attention of the committee has been called to a paper by Lieutenant W. E. Duckering, entitled ''Comments on the Course in Engineering Mechanics as Taught in the Engineer School U. S. Army,'' which presents some very valuable ideas on the manner of presentation of engineering subjects to the student so as to hold his interest and stimulate independent thought. A characteristic quotation is:

''Once the interest of the student has been aroused, and the desirability of individual effort has been established, the next step is to coach and lead him into channels of scientific methods of analysis which will make his independent thought effective.''

This paper bears so directly upon the subject under discussion that the committee would respectfully suggest a reading of it in connection with this report.

It has been impossible for the committee and no doubt for the others to consider the subject assigned without thinking of the Mann Report and realizing that any discussion of the subject was to a marked extent a discussion, as well, of the Mann Report.

May it not be considered significant that the report of this particular committee has been placed on the program at the session set aside for consideration of the Mann Report? The committee trusts its work may contribute to the broader field, but realizes that the time it could legitimately claim at the convention should be devoted directly to the subject assigned. It wishes to repeat that the attention given to the civil engineering curriculum has seemed necessary as a background for the consideration of methods and details of teaching structural design, the subject which was assigned. The committee deliberately attempted to draw discussion upon the details of the structural courses through Professor Morris' paper on "Subject Matter," but no one seemed interested. It is perhaps fairer to say that everyone seemed more interested in the fundamental and general phases of training for structural work.

In referring to Dr. Mann's report once more, it will be noticed that he refrained from making recommendations concerning the content of courses, or the arrangement of a curriculum upon recognizing that these would be governed by local conditions and that general principles would be of greatest value.

If the discussions, and the lack of them. may be a criterion there is no demand for a report on minute details, but there is a readiness to discuss the principles involved.

The committee, therefore, wishes to close its work, and, it hopes, to open a discussion by submitting the following recommendations, some of which were presented in the preliminary report of last year:

1. The general curriculum in civil engineering should be fundamental in character and broad in scope.
2. The structural courses should be considered as a part of the general curriculum and not as independent courses.

3. The structural courses should be so comprehensive and at the same time so fundamental that they will enable the student to understand the main features of the design of structures and, at the same time, serve as a basis for future specialization in college or in practice.

4. The required structural courses should include:

(*a*) Mechanics, including statistics, dynamics and mechanics of materials.

(*b*) An experimental and physical study of the usual materials of construction, including iron, steel, timber, cement and concrete.

(*c*) The theory of reinforced concrete construction with just sufficient design to illustrate and fix the principles involved.

(*d*) An analysis of stress and deflections in framed structures from a general standpoint which may be extended, when desired, to any statically determinate structure, for dead and live load.

(*e*) The principles underlying the design of sections and of details with sufficient work in design to illustrate and fix those principles.

5. The methods employed should be such as to arouse the student's interest and be directed towards the discovery and development, by the student, of the principles involved, rather than to "teach" him certain standard theories and methods.

Summary of Conclusions.

1. The general curriculum in civil engineering should be fundamental in character and broad in scope.

2. The structural courses should be considered as a part of the general curriculum and not as independent courses.

3. The structural courses should be so comprehensive and at the same time so fundamental that they will enable the student to understand the main features of the design of structures and, at the same time, serve as a basis for future specialization in college or in practice.

4. The required structural courses should include:

(*a*) Mechanics, including statics, dynamics and mechanics of materials.

(*b*) An experimental and physical study of the usual materials of construction, including iron, steel, timber, cement and concrete.

(*c*) The theory of reinforced concrete construction with just sufficient design to illustrate and fix the principles involved.

(*d*) An analysis of stresses and deflections in framed structures from a general standpoint which may be extended, when desired, to any statically determinate structure, for dead and live loads.

(*e*) The principles underlying the design of sections and of details with just sufficient work in design to illustrate and fix those principles.

5. The methods employed should be such as to arouse the student's interest and be directed towards the discovery and development, by the student, of the principles involved, rather than to "teach" him certain standard theories and methods.

Discussion.

A. H. Fuller: Since this convention went on record yesterday by adopting the resolutions of the Special Committee on the report of the Joint Committee on Engineering Education, several members have come to me and have suggested that I present the conclusions of this report for similar adoption.

I hesitate to do that for three reasons. First, the Committee did not have that in mind when they were preparing the report, and I have not heard from all the members since it was submitted to them in the present form. Second, there is evidently not time on the program for the discussion which would be necessary for such adoption. Third, I do not believe that final action should be taken upon important matters of policy at the same meeting at which they are presented, unless they have been previously reduced to writing and submitted to the membership.

I think it would be well to extend yesterday's precedent of adopting resolutions to include the adoption of recommendations of committees and, as a practical means of encouraging this, I move you, Mr. President, that this report be received and that the question of adoption be made an item on the program of the next Convention.

Professor Constant: Mr. Chairman, I have not had much time on account of various duties for the last two weeks to give this paper very much thought. I have been simply doing a little thinking since I have been here and since I have spoken with Professor Fuller.

On the whole I think I quite clearly agree with the conclusions of the Committee. It seems to me that they have stated the problems of the structural teaching very precisely.

Taking these points up in the order of *A*, *B*, *C*, *D*, *E*. Of course *A* is an important thing, the study of statics, including almost the entire study of structural engineering: and for a young man who has engineering incentives a thorough course in statics, statics in mechanics taught from an engineering point of view by an engineer or by a teacher with engineering experience and illustrated fully by actual engineering problems instead of the usual stereotyped problems of the books on mechanics would be sufficient. And such a man would very readily become a strutural engineer, or in my mind an engineer as soon as he had related himself to the outside world of practise. Therefore, of course, the important thing in these five points is the stress upon mechanics and the proper way to teach the subject.

B. The laboratory side of it is something that I think probably will bring out considerable discussion within the next year. What weight is to be given to the illustrative value of the laboratory? I think we realize that we can get along without the experimental laboratory. The conclusions of the laboratory are well known: they are in the books, the magazines, and that steel can carry sixty thousand pounds or thereabouts is a fact that the student does not have to go into the laboratory to establish. Neither is it necessary for him to verify the deflection of a beam. He can take that fact for granted; and, therefore, the illustrative value of the laboratory, the exciting of the student's interest and so on, is a matter that is a question of quantity. But how much weight shall be given to that? It is valuable, of course. But to what extent we must go into that is a matter upon which there will be considerable difference of opinion.

C. Reinforced concrete. I am rather inclined to believe that the principles of reinforced concrete should be given along with the course in mechanics; that is, under *A*, other strength materials.

When the student is studying the question of shear, and the principle of stress, diagonal stress, etc., and homogeneous beam, that is the time. it seems to me, to take up the same problems in composite beams. The practical applications of reinforced concrete can or might very well come under *D* or *E*. That is, the more professional problems. Nevertheless. of course, as I said a few minutes ago, I believe in the case method to the extent of illustrative problems, and it should be introduced all along the line.

Now, of course, *A, B* and *C,* as I said a moment ago, would have to compute with the essentials in a course on engineering. However, there is in structural engineering, as there is in the others, all these diagonal branches of engineering, mechanical and electrical engineering. There is a mass of information which the student should acquire, which he should know. For instance, in structural engineering he should know something about momentators and about kilos, and the weights that come upon the structures, and the short-cut methods. Now, for the average student the course in statics will not cover this ground sufficiently. There is too much to be accomplished in that time. So it is proper, it seems to me, that we should spend some additional time upon certain stresses and strains and dynamics, the dynamics of the mechanics.

And then finally of course there should be following the stresses and strains, education by object lessons.

I think that two years ago we swung entirely too far and were too intent on turning out trained draftsmen than turning out men trained in the principles of engineering. Still, it is necessary to spend considerable time upon the design of the individual members.

Now, then, finally I think it is perfectly proper to introduce in an undergraduate course some study of the mechanics of elastic bodies. The static equations that are taught in mechanics, it seems to me, are hardly sufficient.

The average undergraduate certainly should have some conception of what is meant by such elastic equations as are introduced in the study of

$$Dx = \int \frac{M\,yds}{EI},$$

those three equations that play such an important part in the question of the deflection of elastic bodies. That should be introduced in the course somewhere, and perhaps it is a little too early to introduce them in *A*. My own judgment is that a course in structural engineering should include this, with some attention being paid to the so-called higher stresses, although I think that a misnomer, but some attention should be paid to these elastic laws, which an undergraduate can readily grasp and which can be so easily and so beautifully illustrated in the arch and some similar problems. I am afraid we are in the study of arches and problems of that sort more concerned with the design of that particular structure than we are in bringing out the principles; and it is well I think to lay stress upon the principle rather than upon the design. The student should be made to see how those principles will apply to all kinds of problems. Original problems should be thrown at him in the class and in the tests to thoroughly bring out his knowledge of these principles, and the design of a particular arch, reinforcement or otherwise should be more or less incidental to illustrate probably the short cut methods and practical ways that the engineer would adopt in going after his design.

Major More: On account of the lack of time I do not care to present any discussion at this time. But I would like to have the privilege if it is permissible of submitting a written discussion to go along with this later.

The President: Less than one minute. Mr. Williams is on the list next.

J. P. J. Williams: I would like to emphasize Mr. Schmitt's written discussion of this subject, where he proposes that some method be devised for training men in a two-year course. Some kind of a two-year course might be developed to satisfy the demands of practical men for structural engineers in minor positions. That kind of development might possibly come by the application of this "case system," about which we have heard this morning, in the early years of structural courses, and by doing so develop men who can be—I do not want to say flunked out—who can be advised to get into practicla l life, through the mental tests which we discussed yesterday it can be determined that probably certain men would be better off in life if they go busy in practical work. So by introducing the "case system"—and I think it is eminently practicable in the structural courses this method of attack by problems undoubtedly putting the man on his toes, putting a question mark in his mind, he goes for the theory and the principles to the textbook or to the reference books with a seeking mind, which gets results.

The methods employed I think should be radically revised. The lecture system should be abolished, tabooed absolutely. There should be that kind of instruction which makes the man of value for his position—his first chance in practical life; so that the employer will not have to say, "It takes me a whole year while paying this man a salary, to fit him to earn his salary."

F. P. McKibben: I suggest for the Committee's consideration three points.

First, that we teachers of structural engineering who devote all our time to the theory of stresses and the principles of mechanics are making a mistake. We ought to devote a portion of this course to shop operation and shop management, especially as applied to structural bridge shops.

Second, I think it not correct to limit our instruction to ordinary statically determined structures. To turn out the best men we must at least give them the underlying principles of statically indeterminate structures.

Third, we have systems of routing material through shops. Why not come thought to a system of routing men through organizations which design, fabricate and erect bridges and other structures?

REPORT OF COMMITTEE NO. 16—MECHANICAL ENGINEERING.

METHODS OF TEACHING MACHINE DESIGN.

Your committee, which was asked to consider the subject "Methods of Teaching Machine Design," desires to submit the following report:

The courses in machine design, usually required of undergraduates taking a mechanical engineering course, should give the student a thorough training in the fundamental principles involved in the design and operation of machinery. Furthermore, such courses should impart to the student a certain amount of practical knowledge pertaining to the methods used in manufacturing, assembling, operating and repairing machinery of not too complicated a nature. In addition to teaching principles and imparting a certain amount of practical knowledge, the student should be taught how and where to search for additional knowledge to be used in more complicated problems.

In order that such courses be effective, the student must be well grounded in the various shop processes, in mathematics, mechanics and kinematics, in the properties of materials used in the construction of machinery and in the strength of materials. The student must not only be familiar with the principles of mathematics, mechanics, kinematics, etc., but he must have the ability to recognize and apply such principles to the various problems that are presented for solution. In addition to the various subjects just enumerated, courses in machine design presuppose a knowledge of machine drawing and sketching as well as descriptive geometry.

A study of the various methods of teaching machine design in a number of American technical schools seems to indicate that four methods are used. These are as follows:

1. *First Method.*—Students are assigned isolated problems, each one of which is treated independently and has no connection or relation whatsoever with any of the other problems. Some of these problems are frequently of such a nature that they test out the inventive ability possessed by the student. Among the problems commonly met with are the following: Design of riveted joints, pins, key and screw fastenings, shafting and bearings, pulleys and gears of all kinds, couplings and clutches, cams, etc.

2. *Second Method.*—Students working independently or in groups are required to design a certain type of machine or series of machines of the same type, thus bringing out the relation existing between the various elements used in building up a machine. For the reason just stated a considerable number of machine design teachers prefer this method in place of that given in (1) above. These problems may be selected by the individual student or assigned by the instructor. In the majority of cases the machines designed are comparatively simple, containing elements, the design of which involve the use of simple as well as combined stresses. The following machines are or have been used by various teachers: shapers, slotters, toggle-joint presses, punching and shearing machines, hydraulic and pneumatic riveters, cranes, drum hoists, air hoists, drilling machinery, etc.

3. *Third Method.*—Students are given the drawings of comparatively simple machines, such as are mentioned in (2) above, and then are required to make a complete force and stress analysis of all parts or elements used in the machine. Frequently actual machine parts that have failed in service are examined and analyzed in order to determine the probable cause of failure.

4. *Fourth Method.*—Students are assigned a series of problems some of which are of the type discussed under (1) and (3) and at least one problem is of the type discussed under (2), so that the student may obtain a connected idea of an entire machine and how machines are developed from a series

of simple machine elements. This method embodies the good points of all the other methods previously mentioned and has given very good results in the institutions that are using it.

Statement of Problem.—The manner in which a machine design problem is stated and placed before the student, is a very important matter and should receive considerable thought and attention from the teacher or teachers in charge of the courses. Frequently the statement of the problem is incomplete and as a result the student wastes valuable time before he discovers that some important data or statement has been omitted. A good plan, followed by some teachers, is to work out the problems before they are assigned thus any omission or error may be corrected before the student attempts a solution. This plan requires much of the teacher's time, but the results obtained generally warrant such expenditure of time.

In some institutions, where the problems are of the type discussed under method (2) above, the statement of the problem is in the form of a specification in which the essential data are included. Such specifications should be drawn up very carefully so that they may serve as examples for future reference. Another way of making problem assignments is to give a brief statement containing the essential data and then require the student to consult the trade literature for additional help, if it is needed. With problems of this nature it is suggested that the student be made to write a complete specification of the machine as it was designed by him.

Requirements of the Problem.—The student's solution of any problem should include the following: (1) A series of sketches, to be submitted to the instructor for approval, in which the student conveys to the instructor some idea of the details that he expects to introduce into his design. (2) An outline giving in detail the method employed in arriving at the proportions of the various elements used in the machine. This outline, the instructor in charge of the course should discuss with the student before approving it. (3) A series of calculations, accompanied by the necessary free-hand sketches, which should be arranged in a neat and logical manner. Such calculations should be submitted to the instructor at frequent intervals for checking and approval. (4) After the calculations are completed and approved, the student should make a drawing showing the assembly of the machine or of the machine element which he designed. Some institutions merely require a well-made pencil drawing, while others demand both a pencil drawing and a tracing. (5) Having completed the drawing, the student should be required to write out a complete specification of the machine or element of the machine which he designed, unless such a specification formed the statement of the problem. (6) In certain types of problems that are not too complicated it is feasible to require the student to make an estimate of the cost of the machine he designs. This is very desirable, as the student should be given some idea as to the most of machines as well as of the standard parts used in such machines.

In some institutions students are given individual problems while in others, the students work in groups of two or more. With the latter system the best man in the group may be considered as the leader and might then be held responsible for the progress made by the group. The group system has proven highly satisfactory when each group of men was required to design a series of machines, say a series of punching and shearing machines all of which have the same capacity but of different throat depths. It is evident that in such a series of machines there are a considerable number of parts that must be interchangeable, thus compelling the students to coöperate with each other when designing such parts. For example, the ram or slide as well as the back-stand of a series of punching and shearing machines having the same capacity must be designed so that they will fit all of the frames in that series. Furthermore, in order that a double machine may be built, it is necessary that many important dimensions on the various sizes of frames must agree with each other or it is impossible to place two frames back to back.

Qualifications of the Machine Design Teacher.—The essential qualifications of a good teacher for the machine design courses are not different from those required of any good teacher of technical subjects, and may be briefly summed up as follows:

1. He must have command of the subject, that is, he must be well grounded in theory and must have had some practical experience so that he may thoroughly understand the application of the theory to practice.

2. He must keep himself informed as to the latest theories pertaining to special problems in machine design and should keep abreast with modern tendencies in machine design. In short, he should be familiar with the literature of the subject.

3. He should have some knowledge on the economics of the subject under discussion, and impress the student with the importance of economics in connection with machine design.

4. He should be able to inspire and lead the students.

5. He must be interested in the advancement of the engineering profession and its code of ethics.

6. He must be congenial and get along well with his colleagues.

Respectfully submitted,

D. S. Kimball,
F. E. French,
G. F. Gebhardt,
W. T. Magruder,
O. A. Leutwiler,
Chairman.

REPORT OF COMMITTEE NO. 17—ELECTRICAL ENGINEERING.

Your Committee on Electrical Engineering Education has continued during the past year its study of the effects of the war upon electrical engineering education. The concensus of opinion in the various institutions investigated throughout the country seems to indicate that the S. A. T. C. administration, although producing many temporary changes, has effected very little permanent readjustment of the curricula, or teaching methods.

The large S. A. T. C. freshmen enrollment in electrical engineering has been pretty generally sustained and most institutions have a much larger freshmen class than ever before. The upper classes are in most cases below normal, but are being rapidly recruited by former students returning from military service, who seem to be more eager than before to complete their technical training.

The war has given a great impetus to research work particularly in the field of electro-communication, and many more students are entering this branch of the profession than in past years. The establishment of signal corps and field artillery units of the R. O. T. C. in many of the institutions which formally had only infantry detachments, will very greatly assist in maintaining interest in the study of electro-communication.

Extensive vocational training carried on by most institutions during the war has tended to emphasize the importance of practical laboratory and demonstration work in connection with electrical engineering instruction, and has tended toward further correlation of laboratory, classroom and lecture instruction. In some instances, the adoption of more technical training, involving concentric methods of instruction in the freshmen and sophomore years of electrical engineering courses, has resulted.

In short, it is believed that instructional work during the war has in many instances, opened our eyes to possibilities of improvement in our regular technical courses, but has not materially altered fundamental pedagogical principles, nor the subject matter of the curricula.

REPORT OF COMMITTEE NO. 18—MINING ENGINEERING.

Thus far the Mining Engineering Committee has confined its investigation and study to the subject of laboratories for undergraduate students. The committee first attempted to ascertain the prevailing practices in American mining schools in the use of laboratories for the instruction and training of undergraduate students. The results of this investigation were reported to the society in 1917.

The following conclusions and recommendations are now respectfully submitted for consideration:

1. *Mining Laboratories.*—The nature of the equipment must vary with different localities, but as far as possible should be standardized and designed to instruct students in the principles of drilling, breaking ground and supporting excavations. Experimental work with explosives should in general be of a demonstrative character conducted by an instructor of practical experience with small sections of the class at a time, say three or four students in a section.

2. Assay laboratories should be designed to teach principles of assaying and sampling rather than endeavor to reproduce commercial assay laboratories. Speed and routine analysis work should be discussed rather than practiced.

3. Ore dressing laboratories should be laid out with standard small size machinery. Emphasis should be placed on the individual machine rather than an attempt made to connect up a series of machines to imitate the flow sheet of some particular commercial mill. Commercial methods and flow sheets should be discussed in connection with the study of principles on the individual machines.

It is the opinion of this committee that:

1. The above-mentioned laboratories, equipped substantially

as suggested, are essential for the efficient instruction of mining engineering students.

2. The study of metallurgy does not appear to lend itself readily to laboratory practice above that which is afforded in the assay and general chemical laboratories.

3. In nearly every laboratory practice the normal physical, chemical and mechanical actions of small scale operations and small size machinery are consistent with the actions of commercial scale machines and operations. Notable exceptions to this rule are rock drills in mining laboratories and drop stamps in ore dressing.

The investigation of questions of curricula and pedagogic methods seems desirable as the immediate future activity of the committee.

F. W. SPERR,
Chairman.

REPORT OF COMMITTEE NO. 20—STANDARDIZATION OF TECHNICAL NOMENCLATURE.

The first report of the committee as at present organized was made in 1915 and may be found in Volume 22 of the PROCEEDINGS of the S. P. E. E. Summed up briefly, the evidence in possession of the committee at that time showed that there was variation in the spelling and abbreviating of many fairly common technical terms and that the national engineering societies of the country did not agree in their usages. The 1915 report contained a number of these technical terms which were submitted for criticism. Among the questions that arose was the absolute lack of uniformity in the practice of American technical journals in the spelling of compound terms, such as connecting rod, crank pin, which puzzled the committee considerably.

The second report of the committee as at present organized was made in 1916 and may be found in Volume 24, 1916. By this time the committee had had an opportunity to investigate technical compound terms with more care and to consult editors and technical writers. This report gave three rules for the hyphening of compound technical terms which have been discussed a good deal since that time, and which have been adopted, in principle, by a number of the engineering societies as representing intelligent practice. In this connection it may be stated that the four founder societies do not yet agree in the practice of spelling and hyphening technical compound nouns, technical compound nouns being understood to mean expressions consisting of two words which must be taken together correctly to express the concept, such as the expressions boiler room and railroad.

It may interest those of you who have not followed the reports carefully to know that there is wide divergence of practice in the dictionaries of the country in regard to hyphening. After the committee had arrived at its three rules, it learned that the practice it recommended was best represented by the Webster Dictionaries, which also are followed by the Style Book of the Public Printer. Briefly stated, the idea of the committee is that where technical compound terms are used as nouns, as, for instance, railroad, connecting rod, they should not be hyphened. In other words, they should be written either as one word, as railroad, windshield, or as two words, as boiler room. When common practice among men leads to the connecting of the two words into one, as had transpired in the case of railroad and windshield, then it will be time for the technical man to follow; but in no case is the technical compound noun to be hyphened. The committee's rule advises the use of the hyphen in compound adjectival forms. For instance, boiler room is written as two separate words when it is a noun, but in the expression boiler-room economy, a hyphen should connect the words boiler and room, because both the words boiler and room must be taken together correctly to express the meaning intended and because the words occur in adjectival form. There is much difference of opinion about the use of the hyphen, and there are some members of the society who disagree absolutely with the committee, but this rule appears to represent the general tendency at this time and there is a definiteness about it which is extremely satisfactory when the chaos of the present practice is observed.

There is, of course, a lack of definiteness in the use of technical compound terms when used as nouns. Since these are to be written either as solid words or as two words, the choice is narrowed to two possibilities. There is the greatest difference in practice in this regard. The sane and intelligent thing to do seems to be to wait until the man in the street writes the words together. For instance, the word windshield is now written as a solid word because the man in the street thinks of it in that way, and writes it in that way. The term boiler room is probably an older term, but is not in common enough use to warrant writing it as one word; so, while boiler room to the engineer is a distinct concept, yet it appears to be better to write this compound word as two words rather than to attempt to force it upon English-speaking people as one word. There are, of course, a considerable number of people who will insist upon writing some technical compound nouns with a hyphen as representing an intermediate stage between the separate and solid forms. The committee's rule advises the elimination of the hyphenated form when technical compound terms are used as nouns. The study of English and American practice in this regard and the development of the use of the hyphen are extremely interesting. Some very valuable information was obtained from Mr. F. Sturges Allen, editor of the Webster Dictionaries, G. and C. Merriam Company, and a paper on this subject by Mr. Allen will appear in ENGINEERING EDUCATION in the near future. The 1916 report included also a list of technical terms and abbreviations which were approved by the committee and a list of technical terms which were submitted by the committee for discussion and criticism. Members of the society, looking over the lists carelessly, have not always understood that some of these lists were submitted for criticism and had not been approved, although these facts are clearly stated.

By 1916 the committee had secured the coöperation of representatives from most of the national engineering societies, from the Public Printer, from a number of the publishers of engineering books and of technical journals and had conducted a fairly vigorous correspondence with professors and teachers of engineering, because its job was not to formulate new rules of its own, but to discover and make known general tendencies. During 1915 and 1916, a number of individual requests were made that the committee investigate the subject of technical symbols, and it was finally authorized, by the council, to prepare a list for mechanics and hydraulics. The general method of investigating the subject of technical terms is described in the 1917 report of the committee, which appears in the BULLETIN of the society, Volume 8, No. 4, 1917. Letters were addressed to nearly all professors of mechanics and hydraulics in the country and to a number of practicing engineers. The committee found that there was overwhelming approval of the plan to standardize, symbols, but there was wide variation in practice. It obtained many lists of symbols from professors, charted them and prepared a list of symbols, which represented the most general practice so far as the committee could ascertain it. This list appeared in a number of technical journals of the country during 1917 and 1918 and was considerably discussed. It finally lead to the list which was adopted at the annual meeting of the S. P. E. E. in June, 1918, copies of which have been distributed to you this morning.

A few words about this list may not be out of place here. It represents the most general practice as far as the committee has been able to ascertain it. It is itself in doubt about one or two of them. The list is incomplete. It confines itself to a narrow field of engineering and does not cover that field well, but it does represent the beginning of a standard list of symbols in mechanics and hydraulics, which, it is hoped, will grow.

In December, 1918, a meeting of your committee was held in New York to which were invited representatives of the American Society of Mechanical Engineers, American Society of Civil Engineers, American Institute of Mining Engineers, American Institute of Electrical Engineers and the Society of Automotive Engineers. This meeting resulted in the formation of a conference on technical symbols, which will meet from time to time and endeavor to standardize symbols in all technical lines in this country. The S. P. E. E. list is to be used as a starting point in mechanics and hydraulics and the report of the first meeting of the Conference is printed on page 183 in the January, 1919, issue of the BULLETIN of the S. P. E. E.

The following facts about technical symbols appear to stand out clearly:

1. A consistent table of symbols in which each engineering or scientific concept is represented by one symbol and in which that symbol represents only the one concept and no other is impossible at this time. The capital letter *I*, for instance, represents one thing to the electrical engineer and another thing to the student of mechanics and neither will consent to give up his point of view.

2. The list of symbols most carefully worked out is the list of the International Electrotechnical Commission. This is a really international system.

3. We have, to begin with, the list of the International Electrotechnical Commission and the short list in mechanics and hydraulics of this society. Tentative lists should be drawn up for heat engineering and thermodynamics and for other divisions of engineering and science, utilizing the symbols in the electrotechnical lists and in the S. P. E. E. list as fas as possible, until practically all engineering and scientific fields are covered. This will finally result in many letters of the alphabet being used for two or more concepts, which is unfortunate, but inevitable. It will also result, however, in a single concept being represented by one symbol only. For instance, moment of inertia will always be represented by the capital letter *I*. The same letter will represent another concept in the work of the electrical engineer and will represent still another concept in the work of the student of thermodynamics. This is not an ideal situation, but is one toward which we are all moving and is infinitely better than the present chaos.

In conclusion, the active work of your committee at the present time consists in its participation in the Conference on Technical Symbols for which representatives have been appointed from the following societies: American Society of Civil Engineers, American Society of Mechanical Engineers, American Institute of Electrical Engineers, American Institute of Mining Engineers, Society of Automotive Engineers, American Physical Society, American Society of Refrigerating

Engineers, American Engineering Standards Committee, Bureau of Standards, Society of Naval Architects.

Several of the representatives of these societies are now making up lists. After the new symbols have been tabulated and discussed, they will be presented to this society for consideration.

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